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CONTENTS.

VAUGHAN-HORSEY SUPERHEATER.

CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway has, for the past six months, been experimenting with a new type of superheater known as the Vaughan-Horsey superheater. This has been developed, and the patents are being applied for by Mr. H. H. Vaughan, assistant to the vice-president, and Mr. A. W. Horsey, mechanical engineer. Observations and tests which have thus far been made, results of which we expect to be able to present in the near future, show a remarkable economy due to the use of this superheater. The construction is very simple and the cost of repairs should be small. The design is such that any part requiring repair may readily be removed and renewed. The number of joints in the superheater pipes has been reduced to a minimum.

The arrangement of the front end and of the superheater tubes is shown in Figs. 1 and 2. Steam from the dry pipe enters the top or saturated steam header, shown in detail in Fig. 3, and flows through the fingers of the header into 1¼ in. solid drawn weldless steel tubes, inside diameter 15-16 in. These tubes are upset at one end and are forged and bent, by

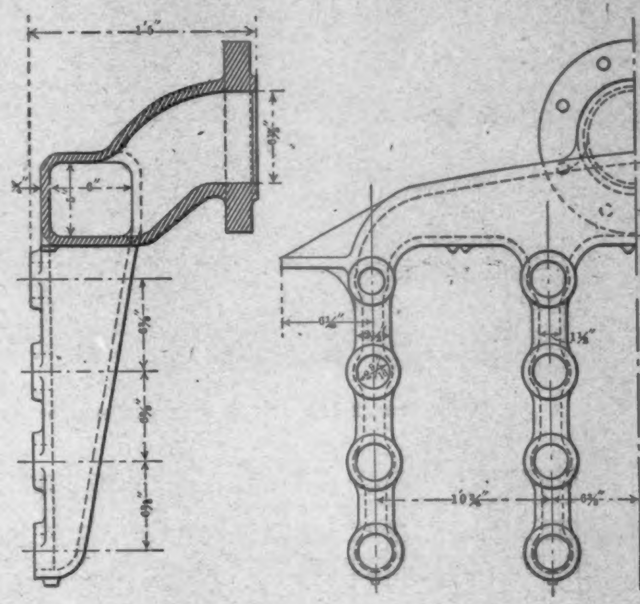


FIG. 3—TOP OR SATURATED STEAM HEADER.

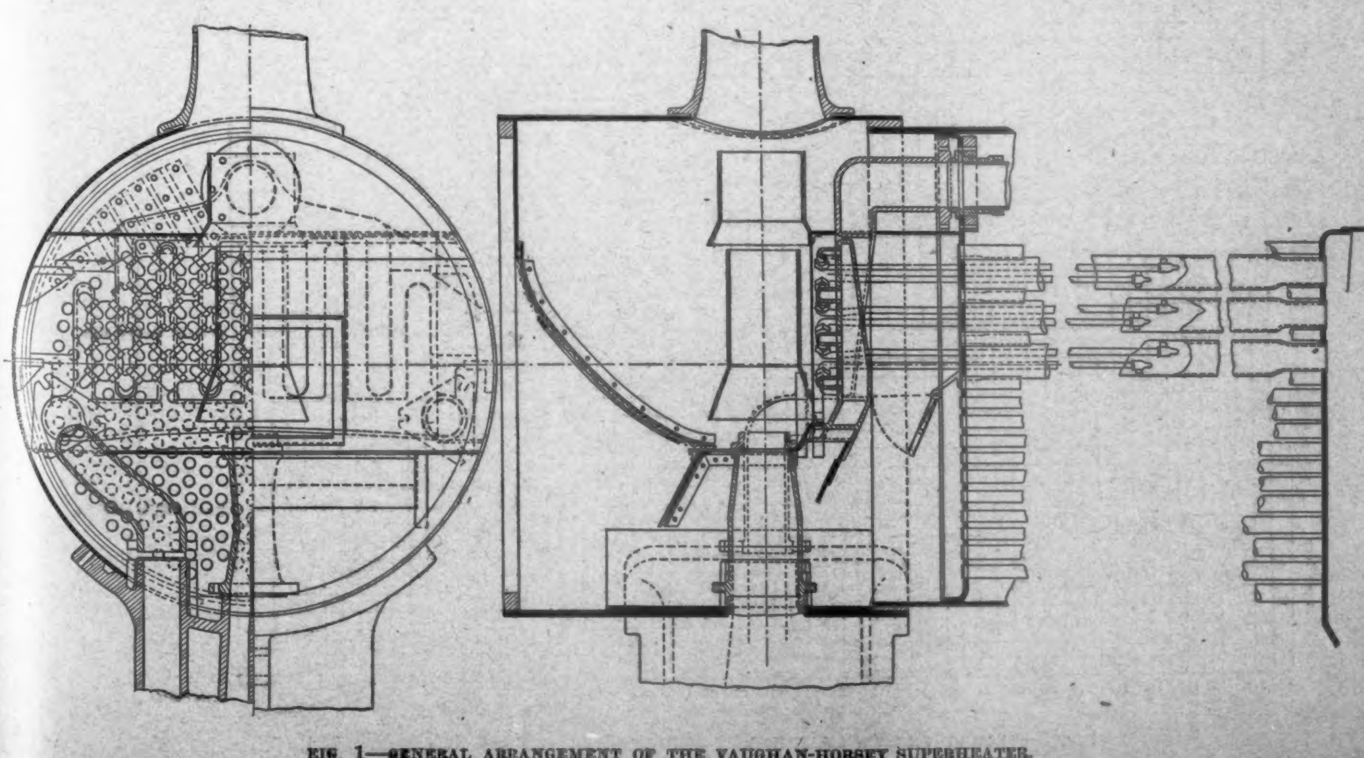


FIG. 1—GENERAL ARRANGEMENT OF THE VAUGHAN-HORSEY SUPERHEATER.

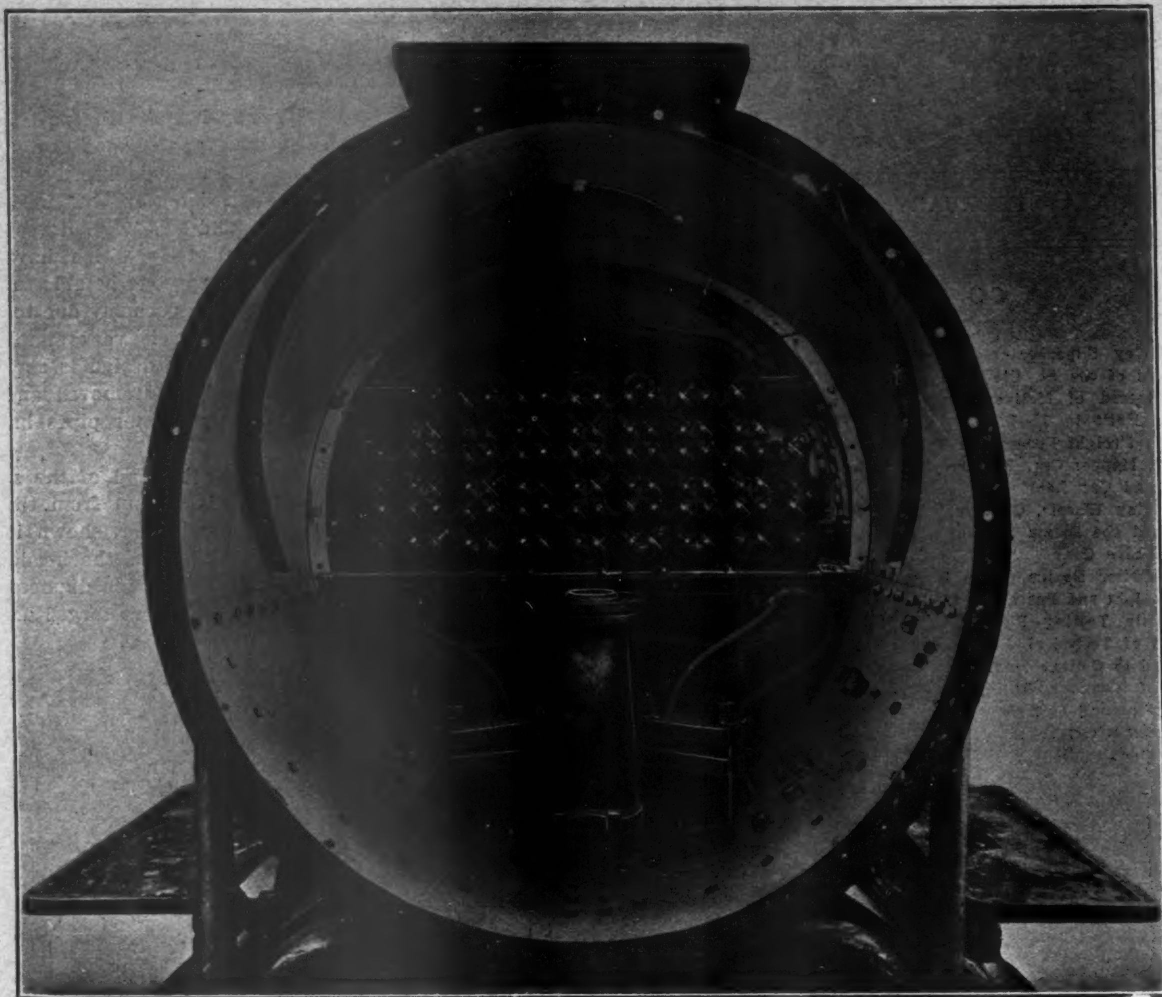


FIG. 2—FRONT END SHOWING ARRANGEMENT OF HEADERS AND SUPERHEATER TUBES.

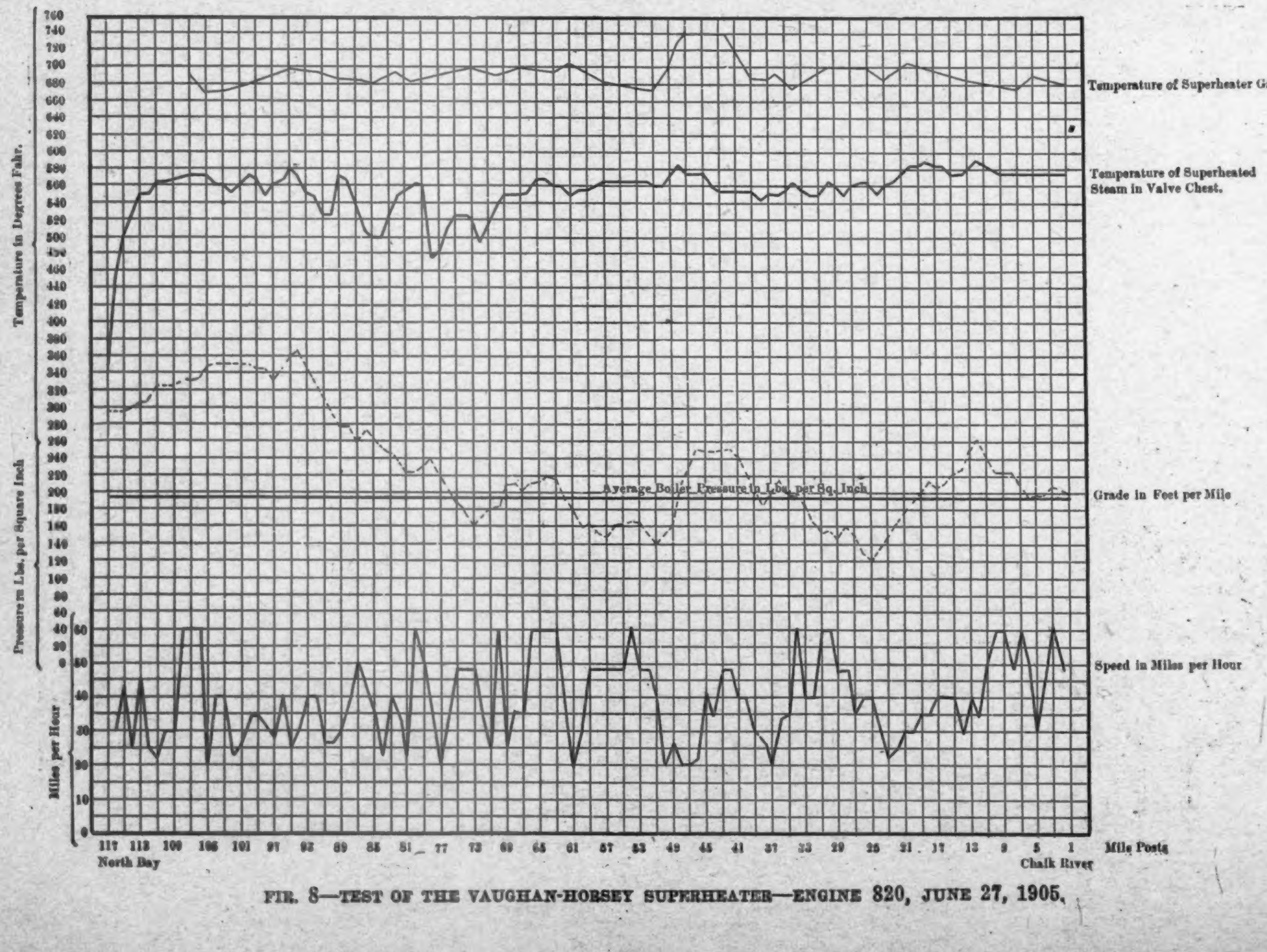


FIG. 8—TEST OF THE VAUGHAN-HORSEY SUPERHEATER—ENGINE 820, JUNE 27, 1905.

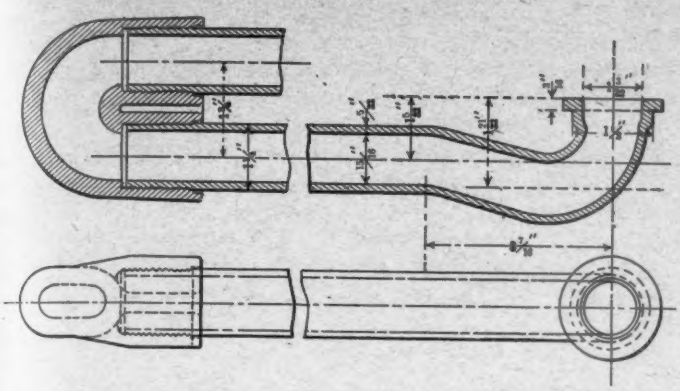


FIG. 4—SUPERHEATER TUBES, SHOWING UPSET END AND CONNECTION TO RETURN BEND.

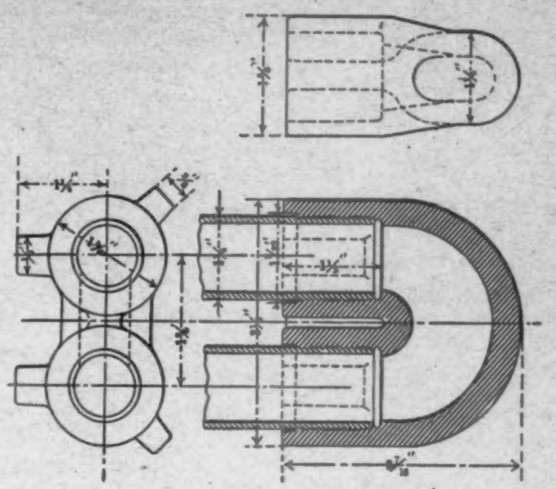


FIG. 5—CAST-STEEL RETURN BEND.

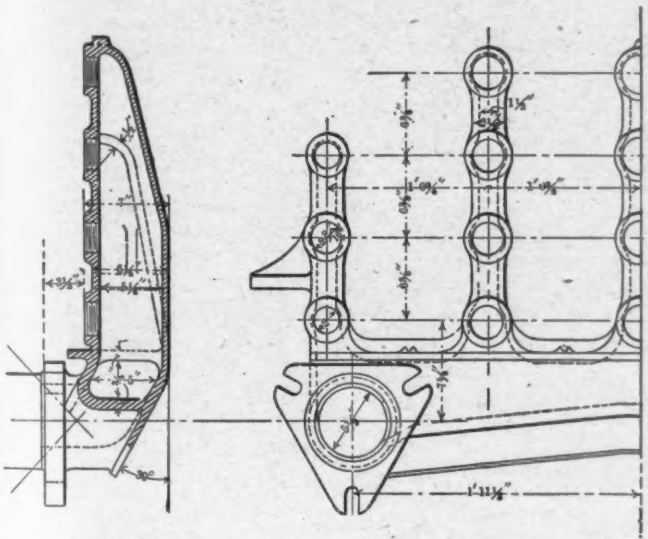


FIG. 6—BOTTOM OR SUPERHEATED STEAM HEADER.

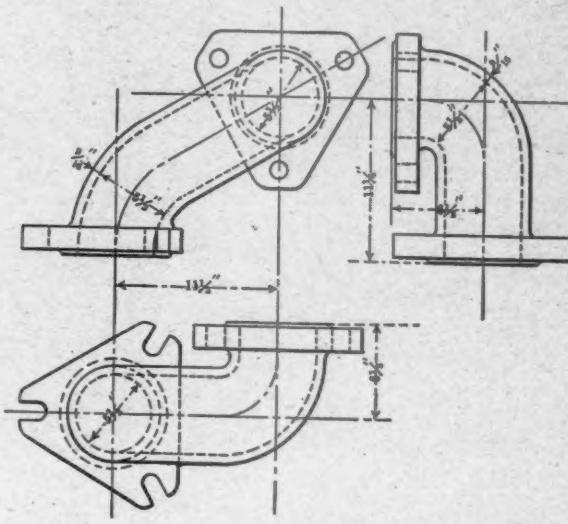


FIG. 7—STEAM PIPE.

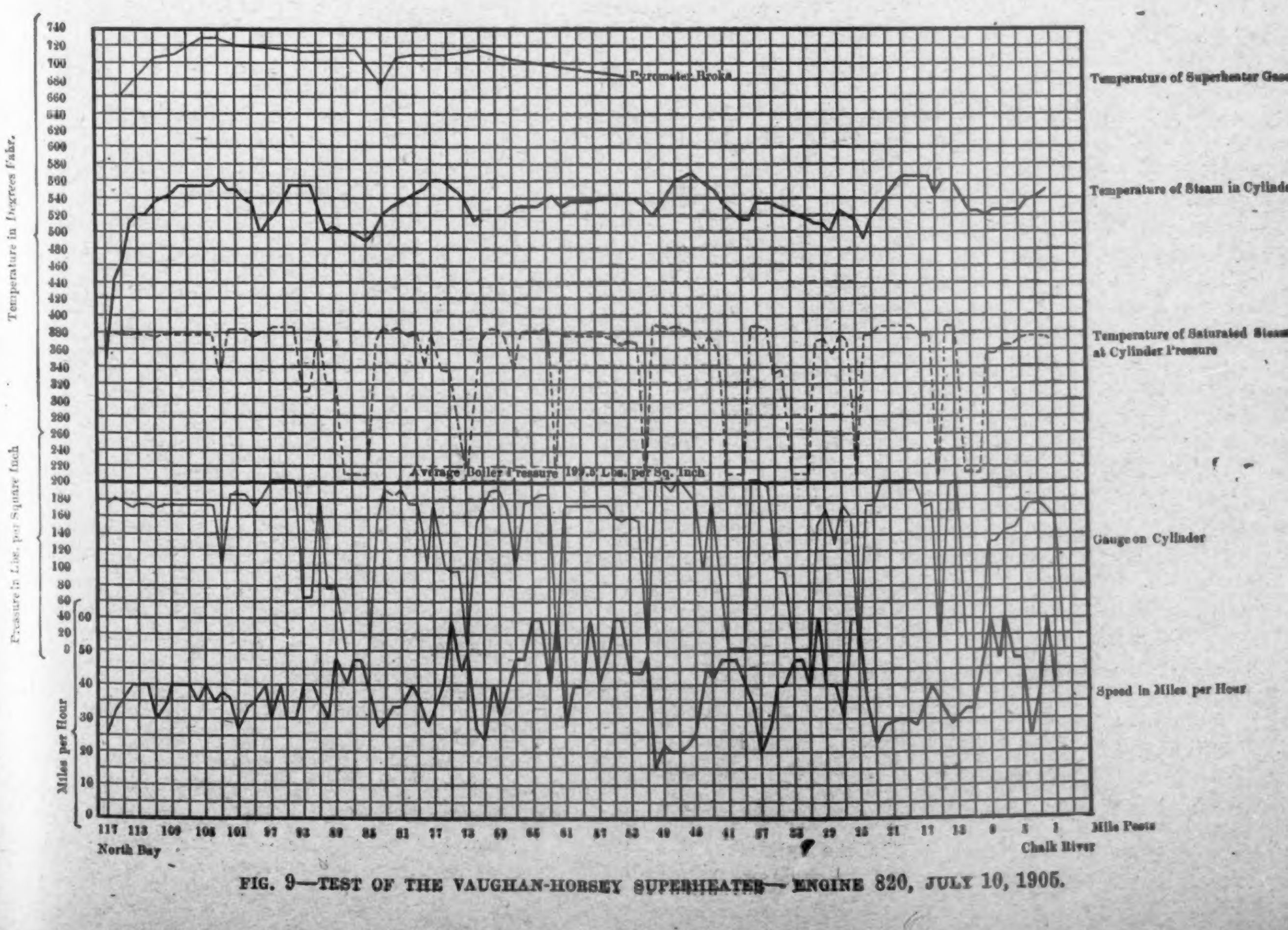


FIG. 9—TEST OF THE VAUGHAN-HORSEY SUPERHEATER—ENGINE 820, JULY 10, 1905.

a bulldozer, to the shape shown in Fig. 4. They are connected by mild steel union nuts to special cast-steel fittings which screw into the header; a 1-16-in. copper wire gasket is used in the union nut. As shown in Fig. 2, these small tubes extend into large 5 in. superheater fire tubes and to within about 30 in. of the back tube sheet, where they connect with the heavy cast-steel return bends shown in Fig. 5. The steam returns from the return bend through 1¼ in. tubes, which connect through union nuts and special cast-steel fittings, similar to those mentioned above, with the fingers of the bottom header, which is shown in detail in Fig. 6. The steam pipes which connect this header with the cylinder casting are shown in Fig. 7, and are necessarily very short; however there has been no difficulty in making the joints tight. Each large superheater fire tube contains two of the small tubes from the top header and the corresponding return tubes to the lower header. The return bend has lugs cast on it, which spaces it properly from the sides of the large tube and the other set of small tubes so that there is a uniform circulation space about the small tubes. The cast-steel return bend is made especially heavy at that part which comes in contact with the smoke and gases from the firebox.

The main difference between this superheater and other types is that the headers are entirely independent and any pair of the smaller tubes may easily be removed and replaced without disturbing the others. The headers containing the saturated and superheated steam being entirely separate from each other, there is no tendency for the superheated steam to be cooled off by the saturated steam. In case it should be necessary to remove the small superheater tubes, or do some work on the large tubes at the front end, it is only necessary to loosen the union nuts and withdraw the small tubes. In case an accident happens to one of the small tubes on the road, it can readily be removed and a blind union or cap placed on the fitting. This can be done in a few minutes and the capacity and efficiency of the superheater is only slightly effected by the loss of a pair of tubes. The 5-in. superheater fire tube, 4⅝ in. inside diameter, is swaged down to 3½ ins. inside diameter for a distance of about 5 ins. at the back end, is threaded and screwed through the back tube sheet and beaded over. At the front tube sheet it is expanded to 5¼ ins. outside diameter and is beaded over. The damper which controls the flow of hot gases through the superheater tubes is operated by a piston working in a 1¾-in. diameter cylinder which takes steam from the steam chest. When the engine is taking steam, the damper is forced open, but when no steam is being used a counter weight closes the damper and prevents the hot gases from injuring the superheater tubes. The light steel plate which is placed in front of the end of the superheater tubes to shut them off from the rest of the smokebox is made in three or more sections and may easily be removed, giving access to all joints, in case it is desired to inspect the superheater.

The following tests of passenger engine 820 which is equipped with one of these superheaters may be of interest. This engine has 20x26-in. cylinders, 70-in. drivers, carries a working pressure of 200 lbs. and weighs 126,000 lbs. on drivers, with a total weight of 165,000 lbs. The average speed, the temperature of the superheated steam in the cylinders, the temperature in the superheater box and the average boiler pressure, together with the number of passenger cars hauled and the coal consumption for several trips made by engine 820 are shown in the accompanying table.

Graphical records of two tests made with engine 820 are shown in Figs. 8 and 9. Ten passenger cars were hauled in each test. The temperature of the superheated steam in the first test averaged considerably more than 550 deg., and in the second case more than 530 deg. In Fig. 9 the calculated temperature of the saturated steam at the cylinder pressure indicated is shown in comparison with the actual temperature of the superheated steam recorded. It is interesting to compare these with similar tests of the two locomotives equipped with Schmidt and Schenectady superheaters, reported in connection with Mr. Vaughan's paper on "The Use of Superheated Steam on Locomotives," on pages 122 and 123 of the 1905 "Proceedings of the Master Mechanics' Association." The temperature of the superheated steam, although it is taken in the cylinders instead of in the branch or steam pipes, as is the case with the Schenectady and Schmidt superheaters, is considerably higher, although these tests are hardly a fair comparison, as the Schmidt and Schenectady superheaters were on consolidation engines in freight service, while engine 820, of a different type, is used in passenger service.

TEST OF PASSENGER ENGINE 820 EQUIPPED WITH VAUGHAN-HORSEY SUPERHEATER.

Date of Test.	Direction.	Average Speed M. P. H.	CYLINDER. Temperature Fahr. Max.	Min.	Ave.	CYLINDER. Pressure Gauge Average.	Average Gas Tem. Super-heater Box.	From Fire Tubes.	Boiler Pressure Average.	Cars Hauled	Tons Coal Burned.	REMARKS.
June 27, 1905.	East.	35.33	590°	500°	554.27°	170.11	690°	Broken.	195	10	2½	
" 27, "	West.	33.85	590°	520°	560.14°	.....	690°	"	202	13	3½	
July 8, 1905.	East.	36.61	570°	495°	530.86°	.....	703°	"	197	7	2¼	Made up 25 min.
" 8, "	West.	30.55	560°	490°	525.°	.....	704°	"	197	6	2½	
" 10, "	East.	35.76	590°	490°	535.05°	139.43	705°	"	200	10		
" 10, "	West.	33.24	590°	495°	546.21°	145.33	....	"	...	9		

ELECTRIFICATION OF ST. CLAIR TUNNEL.

The announcement has been made by the Grand Trunk Railway System that arrangements have been made for the adoption of electric traction in the St. Clair tunnel, the contract for which has been awarded to the Westinghouse Electric & Manufacturing Company, the work to be started at once and brought to completion as quickly as possible. The system that will be adopted is known as the alternating current system with overhead conductors—the conductors in the interior of the tunnel being placed upon the walls, and in the railway yards they will be supported by steel bridges. The trains will be operated by alternating current locomotives, capable of hauling a passenger train on the grade at the rate of 20 to 25 miles an hour, and a freight train of 1,000 tons at the rate of 10 miles an hour. The interior of the tunnel and the yards on both the United States and Canada sides of the St. Clair River will be lighted by electricity from power that will be generated in the extensive power house that it will be necessary to erect.

The length of the tunnel proper is 6,025 feet and of the open portals, or approaches, 5,603 feet additional, or more than two miles in all, one of the longest submarine tunnels in the world. It is a continuous iron tube, 19 ft. 10 in. in diameter, put together in sections as the work of boring proceeded and finally bolted together, the total weight of the iron aggregating 56,000,000 lbs. The work was commenced in September, 1888, and it was opened for freight traffic in October, 1891, a little more than three years being required for its completion. Passenger trains began running through it December 7, 1891. It cost $2,700,000.

Dr. P. E. Shaw in a recent communication to the Royal Society, described an electric micrometer with which he has found it possible to detect a motion of one fifty-millionth of an inch.

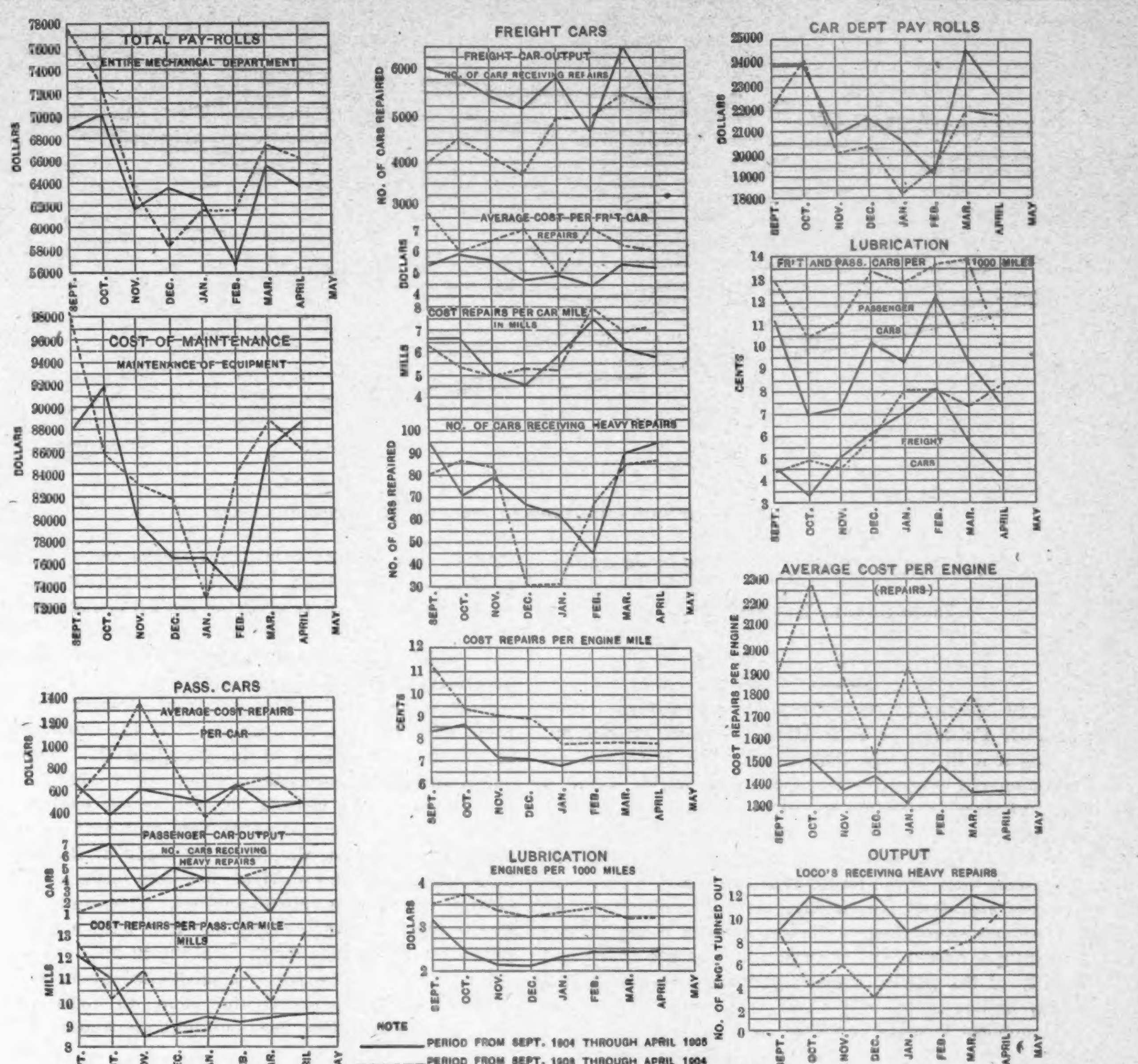


DIAGRAM SHOWING COMPARISON OF EXPENSES AND RESULTS OF THE MECHANICAL DEPARTMENT—KANSAS CITY SOUTHERN RAILWAY.

GRAPHICAL RECORD OF MOTIVE POWER STATISTICS

A series of curves prepared by Mr. W. E. Symons, formerly superintendent of machinery of the Kansas City Southern Railway, illustrate in a graphic manner the improvements introduced in the motive power department of that road, as shown by the standing from September, 1904, through April, 1905, compared with a similar period from September, 1903, through April, 1904. This period includes the winter months and the relative positions of the solid and dotted lines on the diagrams indicate the improvement. The diagrams show in detail the total payrolls, cost of maintenance of locomotives and cars, the output of locomotives and cars, average cost per locomotive for repairs and the cost of lubrication. The diagrammatic method of recording statistics permits the improvement to be noted at a glance, and a few moments devoted to the inspection of these diagrams will serve to show the tendency toward the improvement more clearly than a much longer time devoted to the study of tables of details. These diagrams are presented as an example of the value of graphical statistics to enable the motive power department to not only keep very clear records, but to enable that department to answer questions readily.

These curves show for the motive power department an increase of 2.9 per cent. in the total payrolls in the second period over the first; an increase of 56 per cent. in the output of locomotives; a decrease of 19 per cent. in the average cost of repairs per locomotive; a decrease in the cost of 16 per cent. in the repairs per locomotive mile; a decrease of 29 per cent. in the cost of lubrication per 1,000 miles.

The car department statistics show an increase of 5 per cent. in the payrolls, an increase of 38 per cent. in passenger car output, a decrease of 20.8 per cent. in average cost per passenger car, an increase of 29 per cent. in freight car output, a decrease of 14 per cent. in average cost per freight car, an increase of 11 per cent. in the number of freight cars receiving heavy repairs, and a decrease of 3.2 per cent. in the cost of maintenance of car equipment.

LOCOMOTIVES BUILT IN 1905.—Official returns from all of the locomotive builders in the United States and Canada show that there were 5,491 new locomotives built in 1905, as against 3,441 built in 1904. This total does not include locomotives built by railroads in their own shops, nor does it include orders given for repairs or rebuilding. Of the total number of locomotives reported built, 140 were electric locomotives, as against 95 electric locomotives for last year. Of the total number, 583 were for export and 4,896 for domestic use, including 177 compound locomotives. The total number of locomotives built this year exceeds the total number for any previous year that we have yet reported. The nearest number to it was in 1903, when there were 5,152 locomotives built.—*Railroad Gazette.*

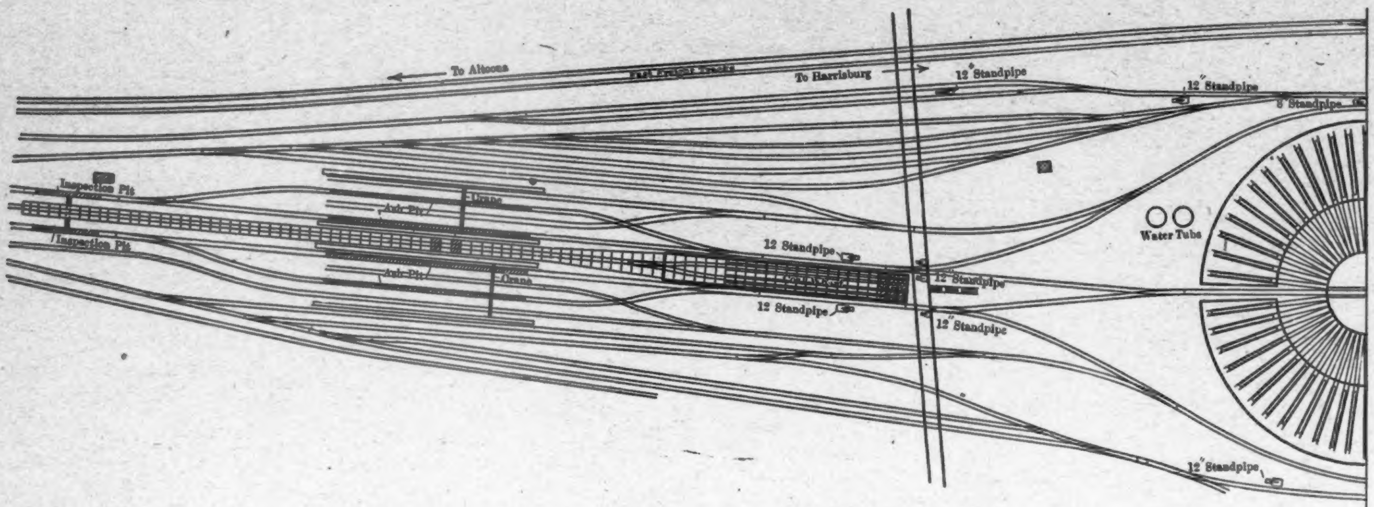


FIG. 1—ARRANGEMENT OF EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

PENNSYLVANIA RAILROAD.

I.

The freight locomotive terminal of the Pennsylvania Railroad, at Blair Furnace, or East Altoona, Pa., which was put into operation a little more than a year ago, is the largest and most complete locomotive terminal in the world. Engines for three divisions—the Middle, the Pittsburgh and the Cambria and Clearfield—use this terminal. At the present time about 300 engines are being handled daily, and on last Christmas Day 214 locomotives were in the terminal at one time. An average of 30 boilers are washed each day. It will undoubtedly be possible to handle a considerably larger number of engines per day, especially if another set of inspection pits are added and the capacity of the power house is increased, both of which can readily be done.

The roundhouse forms a complete circle, and has 50 available stalls, four of which are equipped with drop tables. A space corresponding to two stalls is devoted to a passageway through the house, as indicated on the general plan. Engines are only placed in the roundhouse when they require what is known as heavy running repairs or when the boilers require washing. Engines which require only very light repairs or none at all are placed on the storage tracks.

Locomotives coming into the terminal are first placed on the inspection pits, and after careful inspection pass on to the ash pits, after which they take coal, sand and water, and are then either run into the roundhouse or on to the storage tracks. The storage tracks have a capacity for about 200 locomotives. As may be seen, these tracks are divided into two sections, one of which is used for the Middle division engines, while the larger one is used for the Pittsburgh and the Cambria and Clearfield division engines. As soon as the locomotives which have been placed in the roundhouse have had the necessary work done upon them they are run out on to the storage tracks, so that the roundhouse is used for repair purposes only and not for storage, as is the usual custom. A 100-ft. turn table is used for handling the engines in and out of the roundhouse, while a 75-ft. turn table at the end of the storage tracks is used for turning the engines which do not go into the house, so that they will head out of the terminal in the proper direction. A study of the general plan indicates that careful provision has been made for a free movement of the engines both in and out. The site of the terminal was formerly a large swamp, and it is built entirely on filled ground of an average depth of about 12 ft.

In addition to the features mentioned above the plant includes a power plant, machine shop, oil house, wash house and an office and storehouse building, the upper part of which is fitted with accommodations for the engine crews which have to lay over at this point.

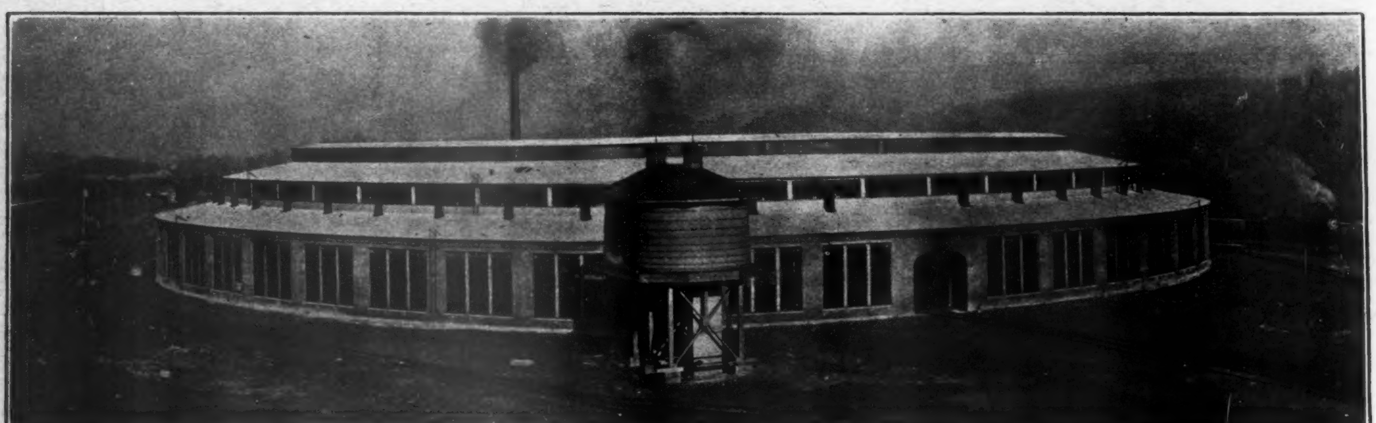


FIG. 2—ROUNDHOUSE, SHOWING TWO OF THE STORAGE TRACKS AT THE LEFT.

INSPECTION PITS.

Two 75-ft. inspection pits are provided, one on either side of the approach to the coal wharf. It is the intention to have these covered over, as indicated in Figs. 3 and 4, although this has not yet been done. There is a passageway between the pits, so that the inspectors can easily pass from one to the other. Ordinarily it takes about three minutes to make a careful inspection of a locomotive. This requires one inspector on either side of the engine and one underneath in the pit. In addition there is one airbrake inspector on the out-

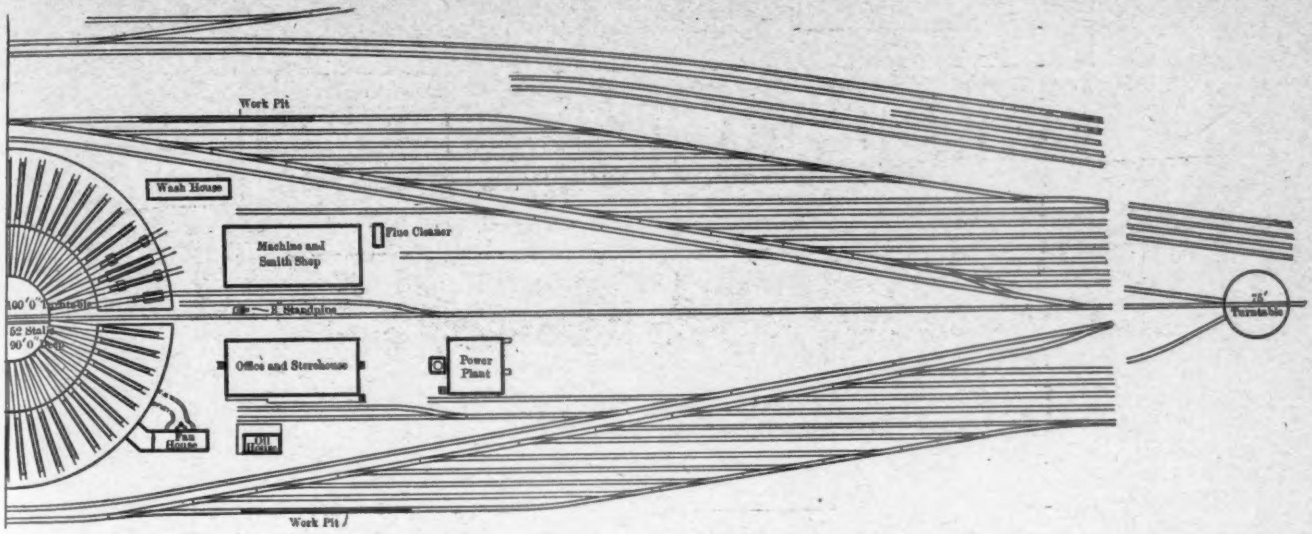


FIG. 1—ARRANGEMENT OF EAST ALTOONA FREIGHT LOCOMOTIVE TERMINAL.

side and one in the cab, who also examines the throttle packing and the cab fittings. The foreman inspector examines the boiler washout and the staybolt tags, and determines as to whether the locomotive is to go into the roundhouse or on to the storage tracks. The walls and floors of the pits are of concrete, and so designed that water falling from the locomotive will quickly drain off. The structure which is to be placed above the pits will have a light steel framework, open at both ends, and the side walls will consist largely of windows. A smokejack will be placed near each end.

ASH PITS.

About 280 ft. beyond the inspection pits are four ash pits, two on either side of the approach to the coal wharf; each is 240 ft. long and will hold four engines. These pits are about trucks which carry ash buckets having a capacity of 48 1-5 cubic feet each. These buckets, shown in detail in Fig. 8, are placed under the engine when it comes over the ash pit, one at each end of the ash pan and one under the front end. After the locomotive has passed off the pit and the ashes have been wet down, the buckets are hoisted and dumped into the cinder cars, which are placed on tracks parallel to the pits. A 5-ton electric traveling crane extends over each set of pits and ash-car tracks. The hoist operates at a speed of 85 ft. per minute; the trolley at the rate of 150 ft. per minute, and the bridge at a rate of 400 ft. per minute. When the ash buckets are ready to dump, they are hoisted high enough so that the two arms on the bucket come into contact with the frame work extending down from the crane bridge and the

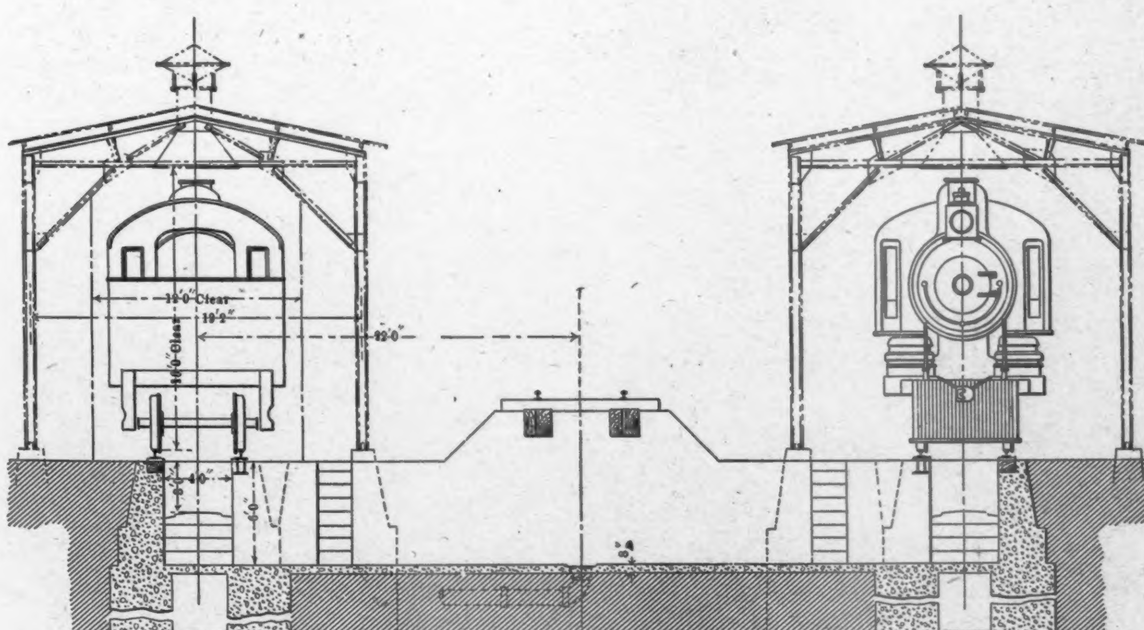


FIG. 3—CROSS SECTION AT INSPECTION PITS, SHOWING CONNECTING PASSAGEWAY.

4 ft. deep, and the walls are of hard, burnt red brick resting upon concrete foundations. The construction is shown in detail in Fig. 7. The pits drain into manholes fitted with removable perforated linings, the bottoms of which are a couple of feet below the center of the sewer pipe. Cinders and dirt settle to the bottom of these linings, or vessels, and, as the dirt accumulates, they may be removed and emptied. The narrow-gauge track on the floor of the pit is for the bucket is forced open. The crane runways are placed on structural steel supports, as shown in Fig. 6.

COAL WHARF.

The coal wharf has fifteen double coal pockets, each with a capacity of 2,136 cubic feet, half of which discharges on each side of the wharf. Provision is made for six additional pockets, if they should be required in the future. The wharf and the trestle leading to it are of timber construction and

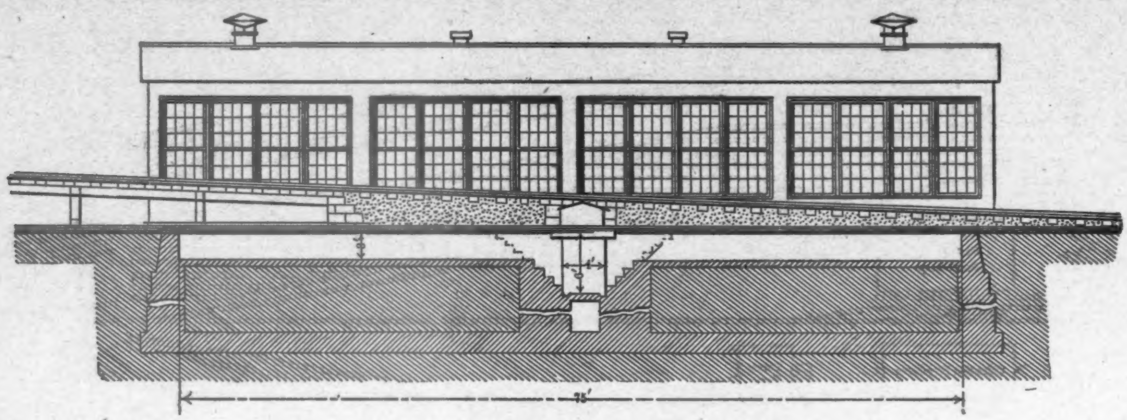
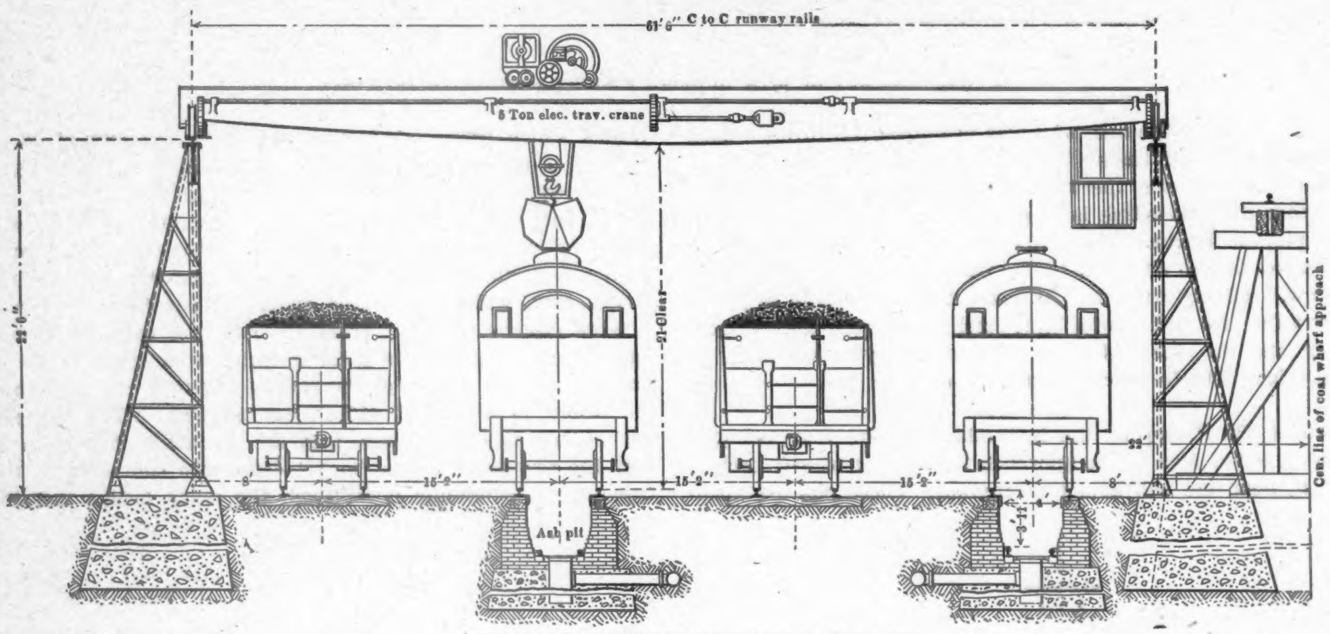


FIG. 4—LONGITUDINAL SECTION THROUGH INSPECTION PIT.



Half Cross-Section through Ash Pits and Crane Runways

FIG. 5—ASH PITS AND TRAVELLING CRANE.

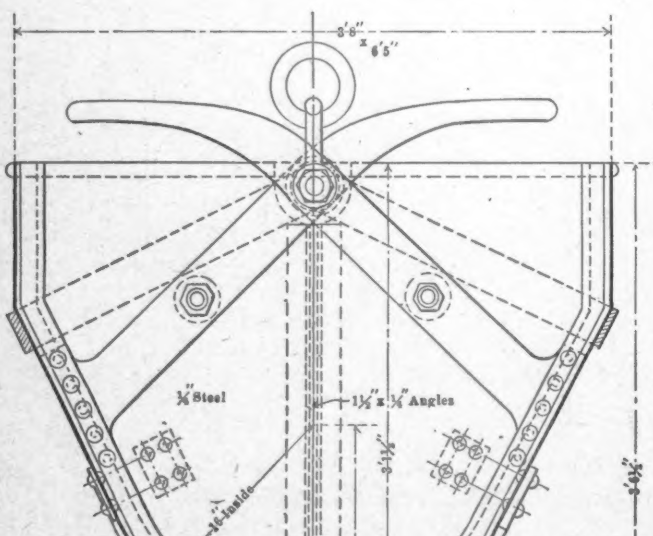


FIG. 8—ASH BUCKET AND TRUCK.

the coal pockets are supported by heavy concrete piers. The approach to the coal wharf is on 3.88 per cent. grade. The top of the wharf is 36 ft. above the ground level. The wharf has a capacity for about 800 tons of coal: at the present time about 1,500 tons are being used daily. Part of the coal pockets are equipped with a special design of Link Belt undercut gate and part with a pneumatically operated gate, designed by the railroad and illustrated in detail in Fig. 12. The air cylinder which operates this door is 6 in. inside diameter. Air may be admitted at either end, depending upon whether the door is to be opened or closed. In the illustration the door is shown closed; when open, it drops so that the flange at the top of the door fits over the top of the coal chute. The deflector at the end of the chute guides the coal toward the middle of the tank.

SANDING APPARATUS.

The general arrangement of the sanding apparatus, which takes up about 36 ft. at the end of the coal wharf, is shown in Fig. 13. Wet sand is delivered directly from the cars on the top of the wharf to the wet sand bins through trap doors. Wet sand is also stored between the concrete piers of the coal wharf and can be delivered to the wet sand bins by a bucket elevator. Directly underneath each of the two wet sand bins is a sand dryer (Fig. 14) which has a drying capacity of 2,000 lbs. per hour. A simple slide-valve regulates the flow of sand from the bin to the hopper. The sand, as it dries, passes through the No. 12 wire netting, 3½ mesh, which is arranged in a cylinder around the stove, and stands almost vertically.

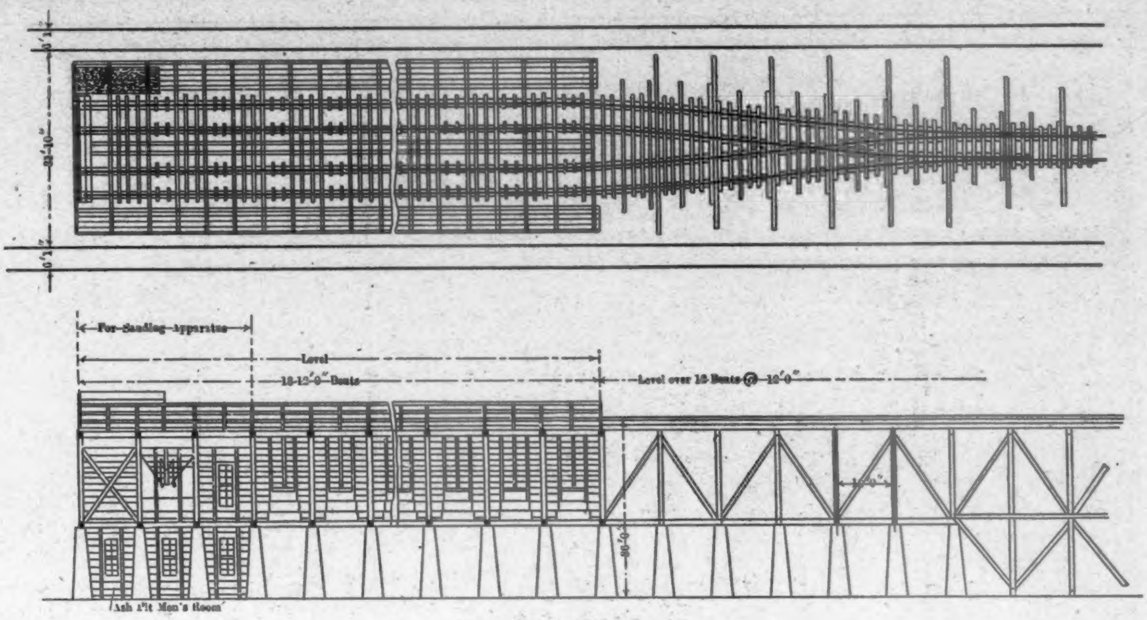


FIG. 9—COAL WHARF.

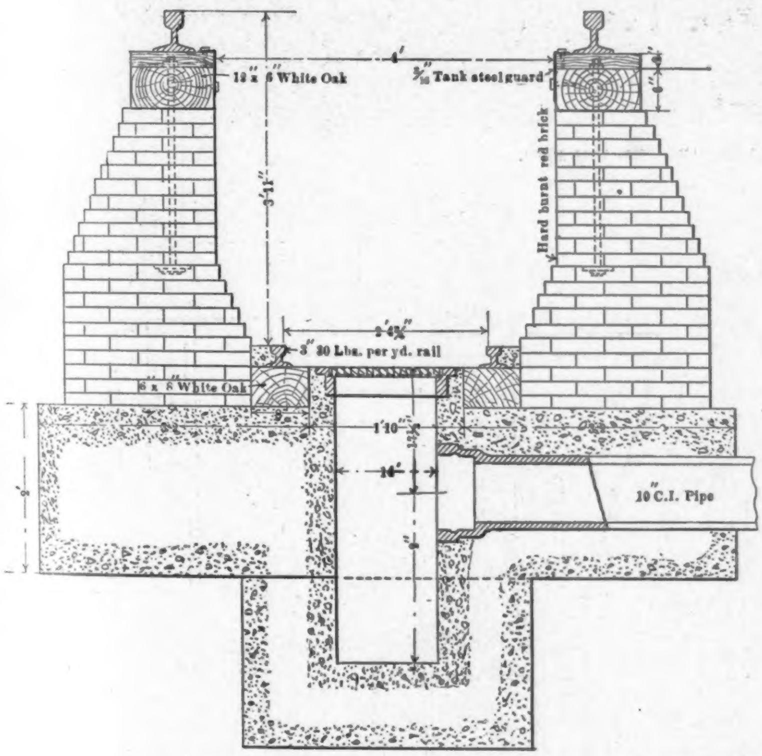


FIG. 7—CROSS SECTION THROUGH ASH PIT.

The pebbles sift to the bottom of the hopper, and slides are arranged at intervals so that they may be removed when necessary. The 1½-in. wrought iron pipe which coils about the stove has 130-¼-in. holes drilled in its bottom. The moisture in the sand, as it takes the form of steam, passes off through this escape pipe, which connects with the chimney.

The dry sand, as it falls from the stove, passes through a double screen consisting of a No. 19 wire, 12 mesh, on a No. 11 wire, 2½ mesh. This is arranged on a slope so that the pebbles will be thrown off to one side. The sand falls into a hopper which connects with a tank, or sand reservoir, which has an inside diameter of 2 ft. 6 ins. and is about 3 ft. 8 ins. high inside. When the tank becomes filled, the operator turns an air valve which, at one and the same time, admits air to the small cylinder, closing the plug valve between the hopper and the tank, and also admits air into the reservoir and forces the sand out through the 2-in. pipe at its bottom and up into the dry sand bins. In a more recent installation, the 2-in. pipe is carried vertically through the top of the reservoir,

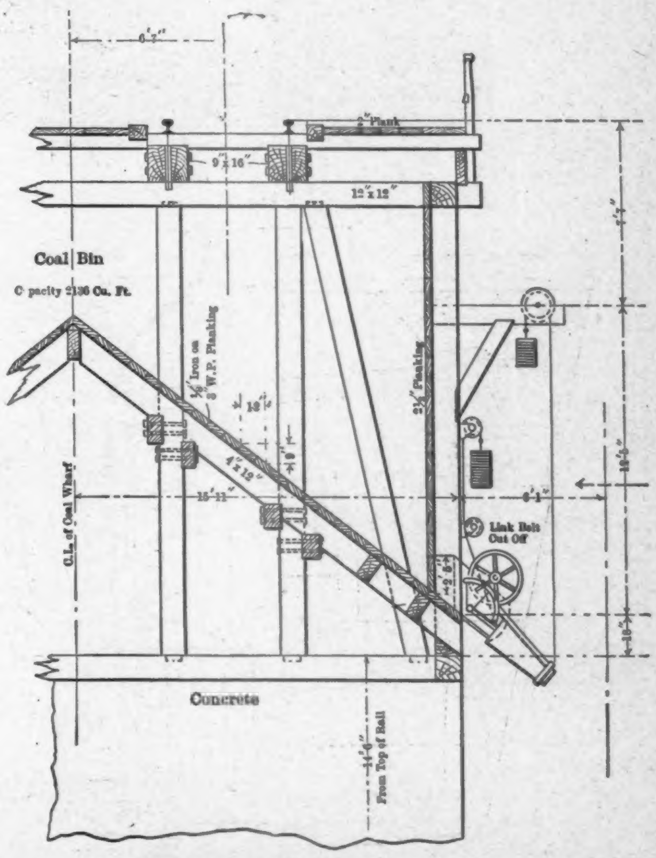


FIG. 11—SECTION THROUGH COAL BIN.

FIG. 6—ASH PITS AND TRAVELLING CRANE.

FIG. 10—COAL WHARF AND ASH PITS.

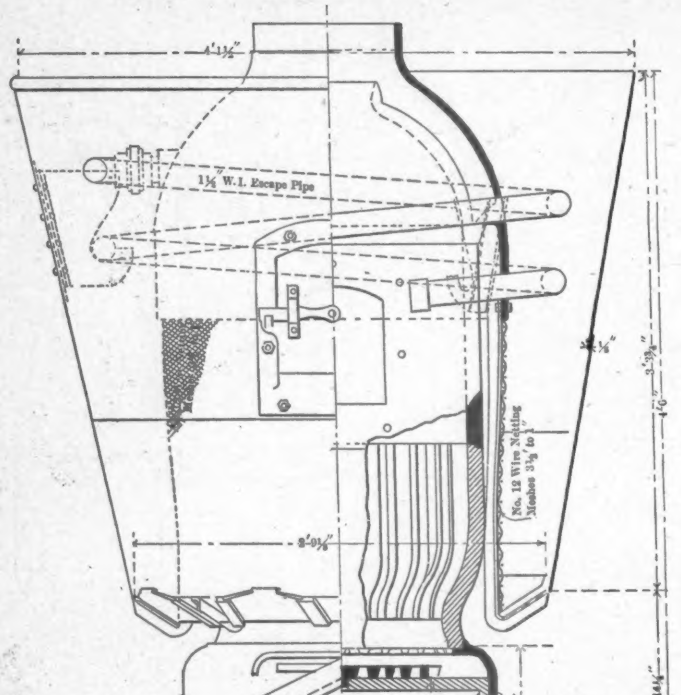


FIG. 14—SAND DRYER.

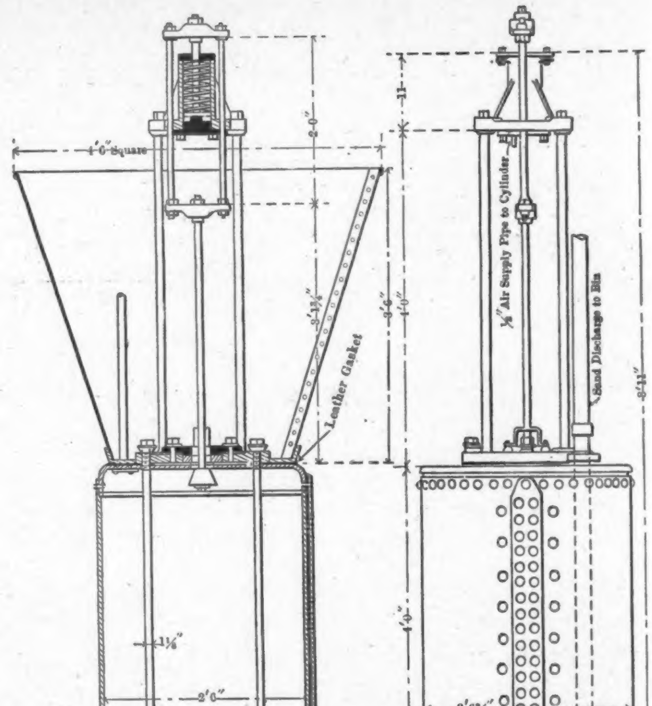


FIG. 15—DRY SAND ELEVATOR.

as shown in Fig. 15, and the sharp bend shown on the general drawing (Fig. 13) is eliminated. The wearing action of the sand at this point makes it necessary to renew the pipe frequently, and this is obviated by using the vertical pipe. The plug valve at the top of the sand reservoir is of steel, case hardened, and seats on a sharp-edged ring. As soon as the reservoir is emptied the air is shut off, and the coil spring in the small cylinder which controls the valve forces the piston downward and opens the valve.

The dry sand bin and the method of conveying sand to the engine are illustrated in Fig. 16. The spout is made of No. 16 galvanized iron and is connected to the casting which leads from the sand bin by a ball joint. The spout is not fastened to this casting, but is held in place by two counterweights; it is thus possible to move the spout up and down or sidewise. The sand valve, which is raised off its seat by pulling the cord, is made heavy enough to quickly drop into place when the cord is released. Any sand which may remain in the ball joint falls into the funnel when the spout is raised and is conducted to the hopper at the sand reservoir; as the spout is elevated, the small lid at its end drops over the opening and prevents rain or moisture from entering.

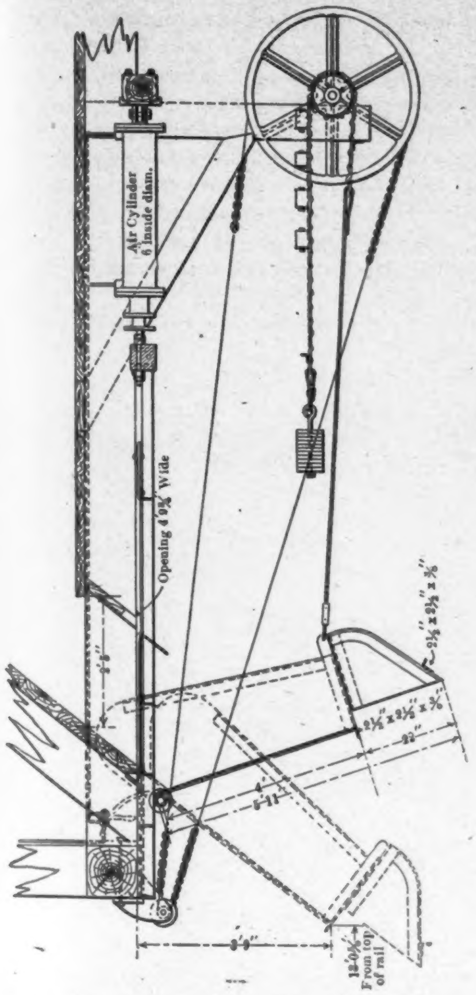


FIG. 12—PNEUMATICALLY OPERATED COAL GATE.

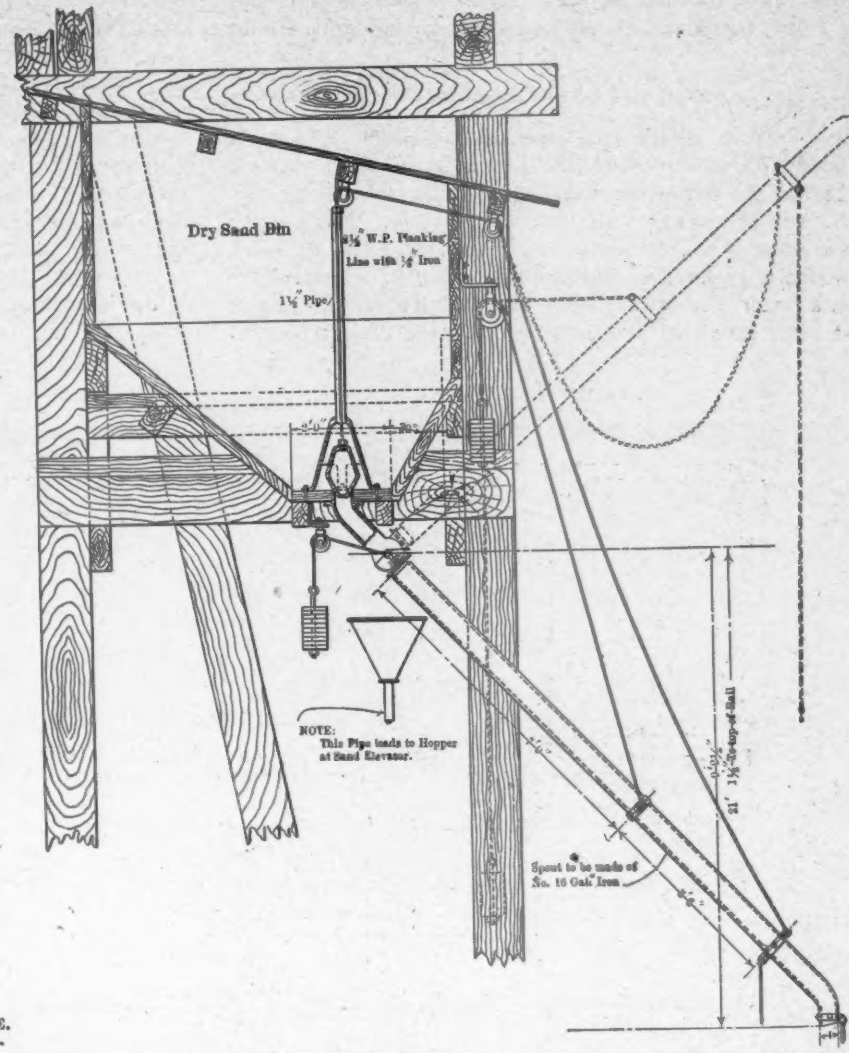


FIG. 16—DRY SAND BIN AND DELIVERY APPARATUS.

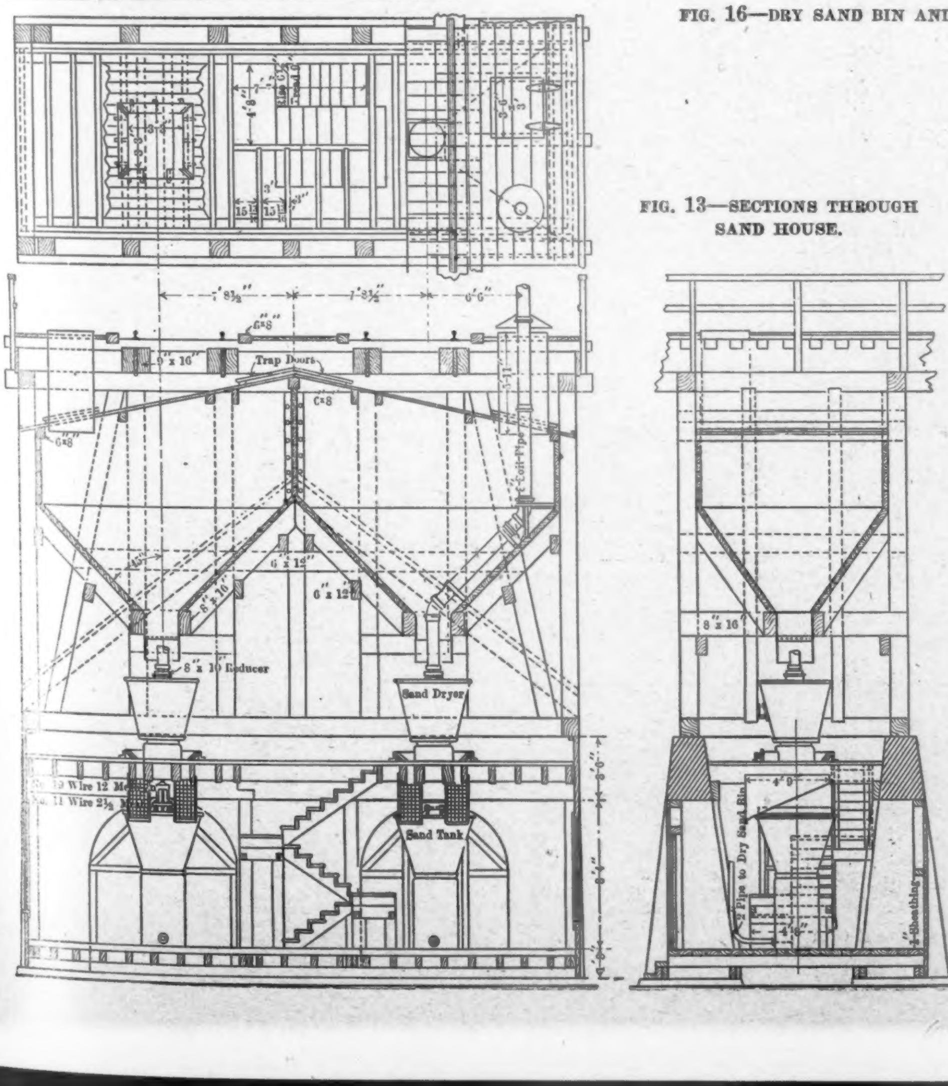


FIG. 13—SECTIONS THROUGH SAND HOUSE.

STORAGE TRACKS.

After an engine has been inspected and had the fire and front end cleaned, and after having taken coal, sand and water, if the boiler does not require washing and no heavy repairs are needed, it passes around the side of the roundhouse to the storage tracks. Each storage track holds only six or seven engines, and this, in connection with the arrangement of tracks leading to and from the storage tracks, makes it possible to take out any engine with a minimum amount of trouble. The tracks are spaced 15 ft., center to center. Steam is kept up and the fires are looked after by an "engine watcher," each watcher being responsible for the engines on two tracks.

The 75-ft. turntable at the end of the storage tracks is driven by a 12½ h.p. General Electric 220-volt motor. The design and construction of the table is similar to that of the 100-ft. table, which will be considered in connection with the description of the roundhouse.

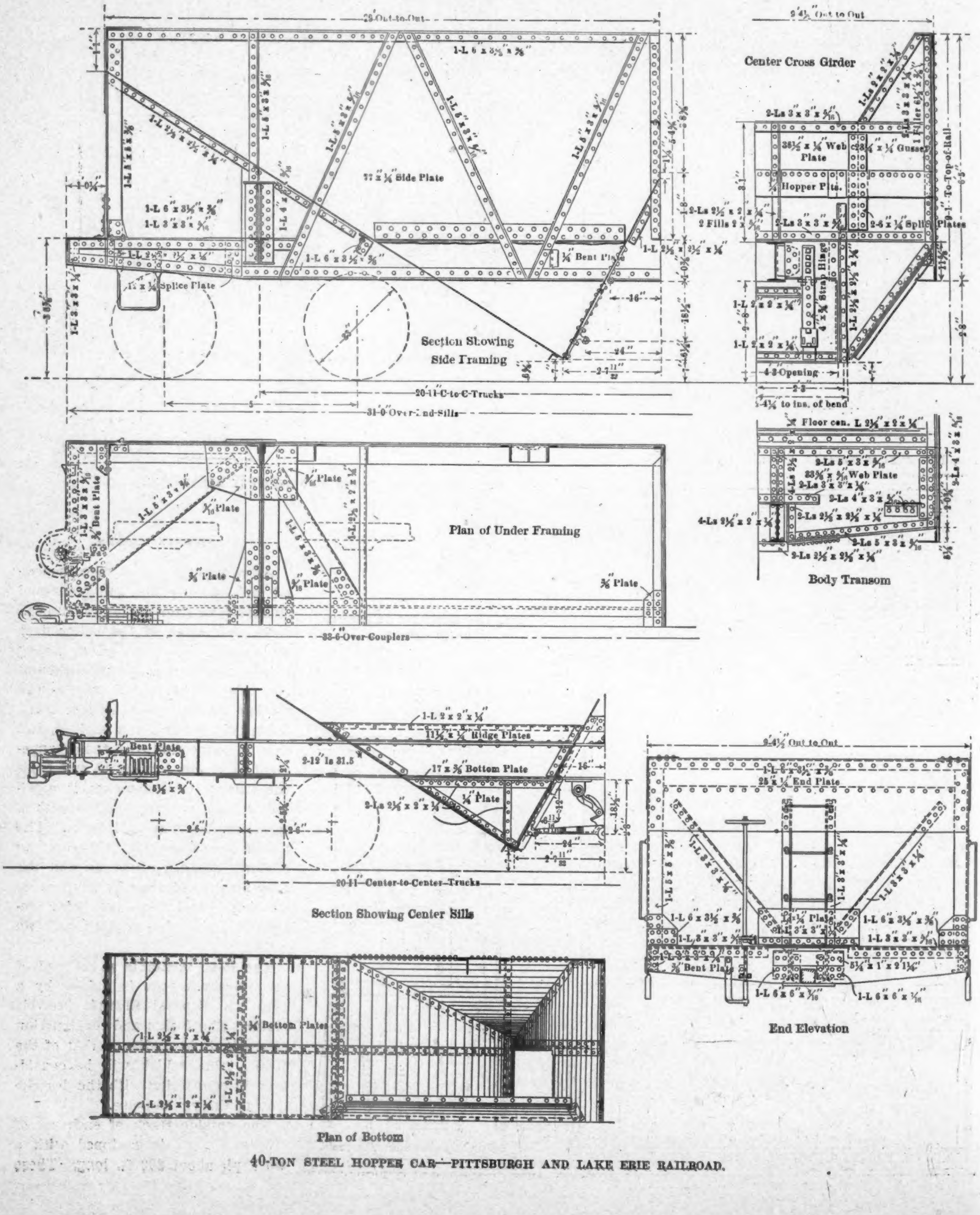
The outside track of each set of storage tracks is equipped with a work pit about 200 ft. long. These

pits are used for making light repairs, such as adjusting wedge bolts, tightening up loose nuts and for sponging driving boxes.

WATER SUPPLY FOR LOCOMOTIVES.

There are two 12-inch standpipes, one on either side of the coal wharf, opposite the coal pockets, and there are three more just beyond the end of the wharf towards the roundhouse, two on one side of the wharf and one on the other. These standpipes are placed in this position so that in whichever direction the engine is heading, or whether it is going in or around the house, a water plug will be convenient to the tender manhole at the same time that the sand box is under the sand spout. On either side of the roundhouse, between the ingoing and outgoing tracks, is an 8 in, emergency standpipe, which is supplied with water from the regular high-pressure service supply line. There is another one of these 8-in. emergency standpipes just beyond the roundhouse, towards the storage tracks. In addition to these, there are three 12-in. standpipes located on the outgoing tracks, two of these on the side used by the Pittsburgh division and one on the side used by the Middle division engines. The 12-in. pipes are supplied from the two large water tubs. The water supply, as well as the other features of the terminal, is arranged to take care of all possible emergencies.

(To be Continued.)

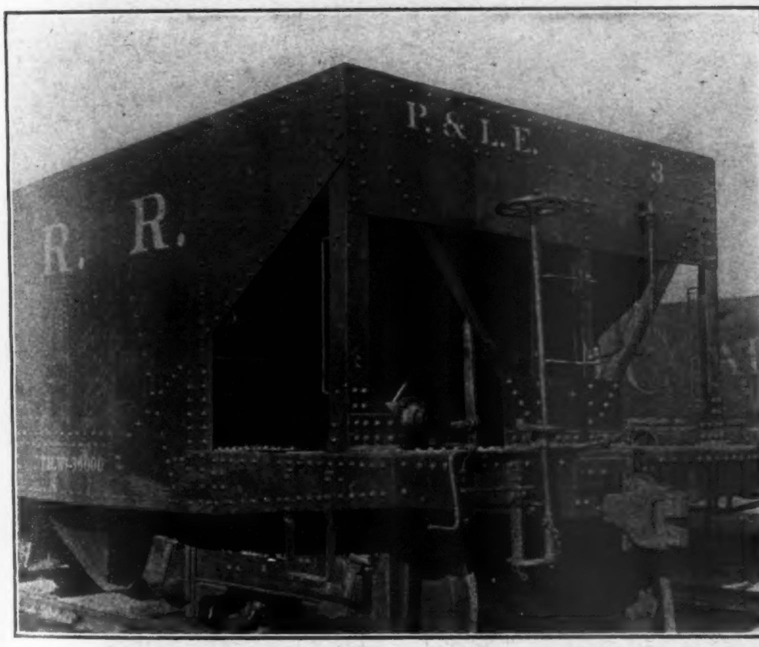


40-TON STEEL HOPPER CAR—PITTSBURGH AND LAKE ERIE RAILROAD.

AN IMPORTANT EARLY DESIGN OF STEEL CAR.

The first steel car built for the Pittsburgh & Lake Erie Railroad was one of the first steel cars to be placed in actual service in this country, and is a very important one, because of the satisfactory manner in which it has stood the very heavy service to which it has been subjected, and also because the various features, although of original design, were not patented; in fact, for this reason the car has proved rather an important factor in the steel car patent litigations during the past few years.

The car is of the hopper type, of 80,000 lbs. nominal capacity, and was designed and built during the latter part of 1897 under the direction of Mr. L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie Railroad, by the Youngstown Bridge Company, Youngstown, Ohio. Since that time it has been in constant service, the greater part of the time in a limestone district, where the service is specially severe and the cars are always loaded to their maximum capacity. In spite of this, the car is in practically as good condition to-day as when it was placed in service, eight years ago. In all that time there is no record of any repairs being made, except ordinary repairs to the draft rigging. Not only have no repairs been necessary, but there is no distortion of the top sides, ends or any other part of the body of the car.



40-TON STEEL HOPPER CAR—P. & L. E. R. R.

There are several features of the design, such as the stiffener angle on the top of the sides which projects inward, and the diagonal braces on the inside of the side sheets, which at the present time would be considered objectionable because of their interfering with the unloading on an unloading machine. The car is undoubtedly considerably stronger than cars of the same capacity which are being built at the present time, and there are several features of the design which are worthy of careful study by the steel car designer of the present day.

The general dimensions are as follows:

Height over the sides	9 ft. 1 in.
Width over the sides	9 ft. 4½ ins.
Length over the ends of the hopper	29 ft.
Width, inside clearance at top	8 ft. 4¼ ins.
Length, inside clearance at top	28 ft.
Center to center of bolsters	20 ft. 11 ins.
Truck wheel base	5 ft. 6 ins.
Length over endsills	31 ft.
Cubic capacity	1,335 cu. ft.
Light weight	35,600 lbs.

The center sills are 12-in. I beams, 31.5 lbs. per foot, and extend the full length of the car. The lower inside flange is cut off for a distance of 15½ ins. near each end, to make room for the draft rigging. The end sill is a ⅜-in. bent plate, reinforced by a 3 x 3 x 5-16-in. angle, as shown. The side sheets, two on each side with the joint at the center, are reinforced at both the top and the bottom by 6 by 3½ by ⅜-in. angles, the longer leg of the angle being at right angles with the side sheet and projecting inward. In addition there are diagonal braces on the inside of 5 by 3 by 5-16-in. angles, with the longer leg at right angles to the side sheet. The body is also tied together at the center by a cross girder and gusset, as shown on the general plan. This makes a very strong and rigid construction.

There are two hopper doors, and as the opening is only 4 ft. 3 ins. wide the sides of the hopper are sloped inward toward the center of the car. The center sills are covered by an inverted V-shaped plate, but the sides and bottom of the sills are unprotected. The drop door mechanism is known as the King patent. The body bolster, which is shown in detail on the view showing the general arrangement of the car, consists of a 5-16-in. plate with angles riveted at the edges on both sides; a tie plate riveted to the bottom angles passes underneath the center sills. The ends of the hopper are supported at the corners by upright 5 by 5 by ⅜-in. angles and by 3 by 3 by ¼-in. angles which extend diagonally to near the center of the car. The trucks are of the old Schoen pressed steel type.

LOCOMOTIVE AND CAR BEARINGS.

In a communication presented before the recent meeting of the American Society of Mechanical Engineers, by Mr. G. M. Basford, he stated that the unknown quantities in the matter of stresses to which locomotive parts are subjected place locomotive design in a class by itself. In the matter of locomotive bearings, it is of little practical use to study the coefficient of friction. Rules for bearing pressures, which are entirely satisfactory for other construction, will not answer at all for locomotives. Bearing areas for locomotive journals are determined chiefly by the possibilities of lubrication. They are affected by the very severe service to which locomotives are subject, and the presence of dust, sand, ashes and cinders must be reckoned with. Concerning locomotive bearings, experience has shown that crank-pins may be loaded to from 1,500 to 1,700 lbs. per square inch. These bearings are subject to alternating stresses, rendering lubrication relatively easy, and lubrication is really the limiting factor in locomotive bearings. Wrist-pins may be loaded to about 4,000 lbs. per square inch, because their rotary motion is not complete, and the thrust changes twice in every revolution.

With journals the case is different. For locomotive driving journals it has been found that the following figures give good service: Passenger locomotives, about 190 lbs. per square inch; freight locomotives, 200 lbs. per square inch; switching locomotives, 220 lbs. per square inch.

Car and tender journals present the condition of beams fixed at one end and loaded more or less uniformly. In these cases, two limitations to the size of the bearings are presented: The fiber stresses of the journal must not be too high; there must be sufficient bearing area to insure cool running. As a rule, the various sizes of axles adopted as standard by the Master Car Builders' Association may be loaded slightly more in pounds per square inch of projected bearing area without exceeding the allowable fiber stress, than would be permissible to provide properly against heating; but both of these limitations must be borne in mind. Car and tender bearings are usually loaded from 300 to 325 lbs. per square inch of projected area, but even this unit load is misleading, because in parts the load per square inch of actual bearing area may be very much higher because of the rough character of the bearing.

The Pittsburg & Lake Erie Railroad report for 1905 shows a gross earning of $67,500 per mile, probably the largest amount of any road in the country.

TURNING DRIVING WHEELS.

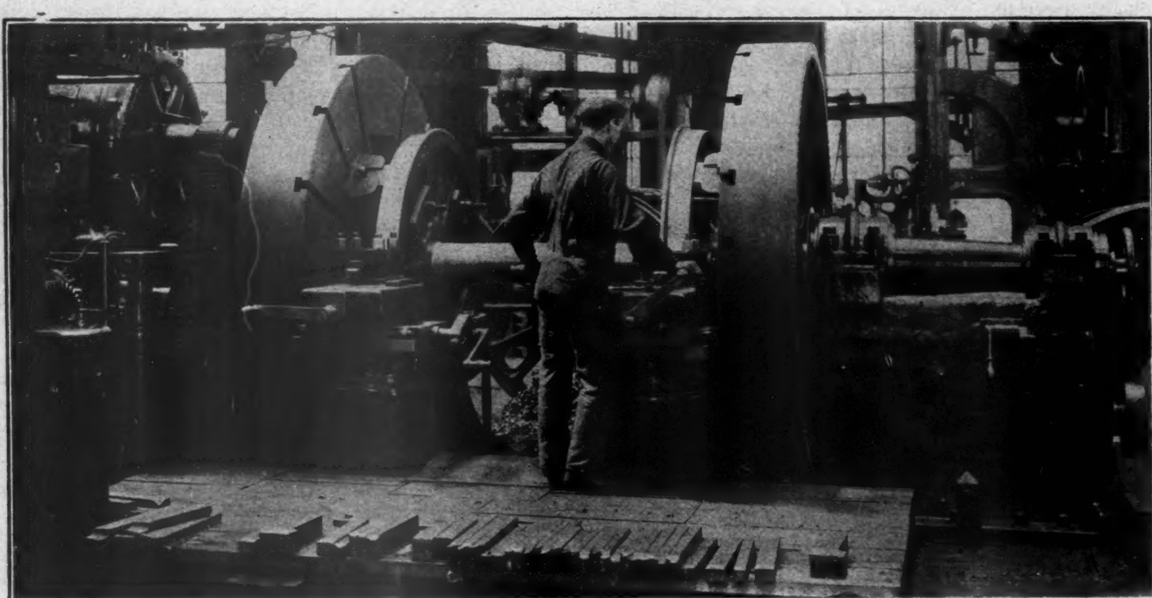
BY GUSTAVE GIROUX.*

With a powerful up-to-date driving wheel lathe, high speed steel tools and a good organization it is possible to very greatly increase the output over that obtained under ordinary conditions. The reports which have appeared in the technical papers, from time to time, have been received by many with doubt, and it is the purpose of this article to explain in detail just what steps have been taken to increase the output at the Angus shops.

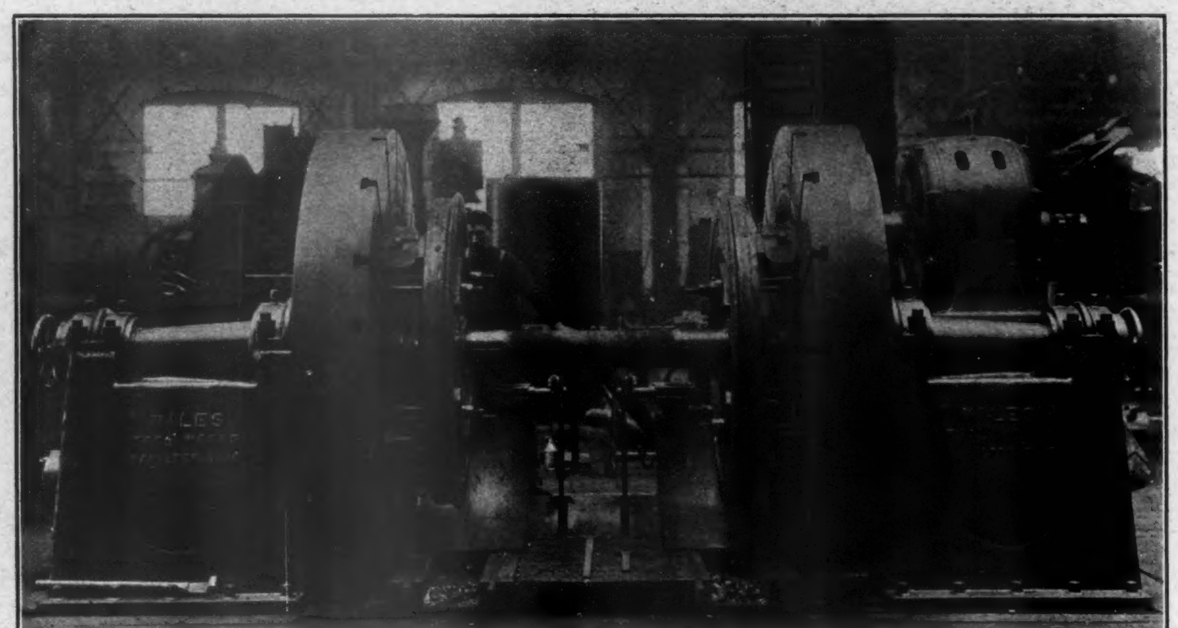
While there are a number of different makes of driving wheel lathes on the market there is more or less difference as to the amount of work which they can turn out in a given time; even the best one might be a disappointment to those who paid a high price for it if attention and consideration were not given to the conditions and organization surrounding it, for these are as important to the output as the machine itself and one is of little use without the other; perhaps it is just these two things which have caused disappointment because of the small output of some expensive and modern wheel lathes which have been installed.

The following statements are based upon the results obtained from a 90-in. driving wheel lathe, direct motor driven, weighing 100,000 lbs., which has been forced and has been in daily service for over twelve months and all it has cost for repairs during that time, both labor and material, would be covered by a ten dollar bill. Such a machine should be set upon a good solid foundation with the top of the base plate or bed practically level with the shop floor. The openings in the bed plate, or pit, should be covered so as to prevent workmen from being hurt by falling or getting caught in them, as well as to prevent the accumulation of dirt and cuttings, and thus keep the surroundings cleaner and more comfortable for the workmen.

Good sheet iron shoots with flanges should be fastened to the tool posts or rests so as to catch the cuttings as they fall from the tools, and slide them down towards the back of the machine where the helper can conveniently remove them without danger and without interfering with the operator or the running of the machine. On the front side of the machine, or the operator side, a good platform of conven-



FRONT VIEW WITH SHELF FOR TOOLS REMOVED IN ORDER TO PRESENT A BETTER VIEW OF THE MACHINE.

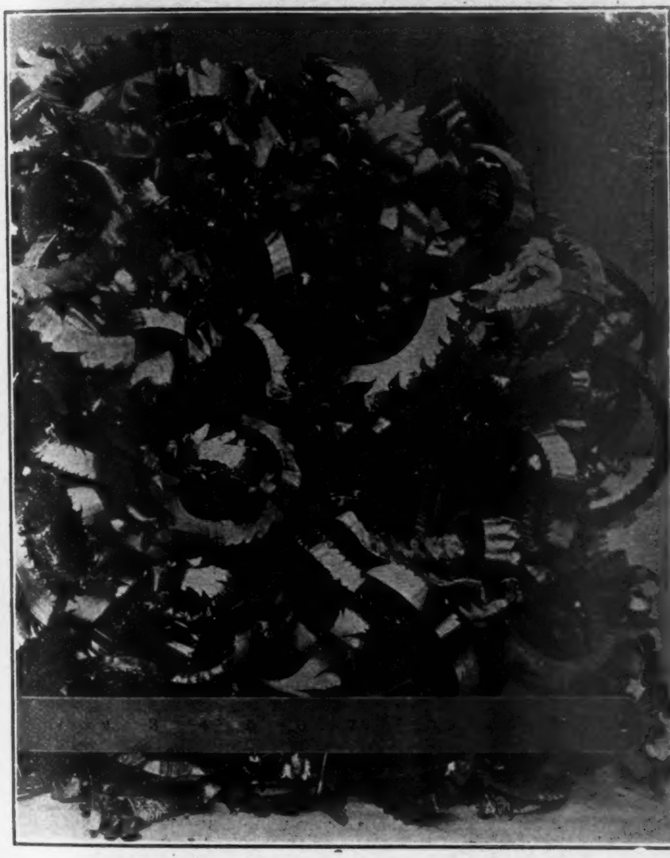


REAR VIEW, SHOWING SHEET IRON CHUTE FOR CUTTINGS.

90-INCH DRIVING WHEEL LATHE—ANGUS SHOPS.

*Canadian Pacific Railway, Angus Shops.

ient height and the full length of the machine should be built and upon it a shelf should be placed for keeping tools, etc. The height of this shelf should be about the same as the tool rests, for the convenience of the operator in handling the heavy tools to and from the machine with as little difficulty and exertion as possible. It is also important to have a full set of good wrenches. Two long handle wrenches should be kept, one on each side of the tail stock to loosen or fasten it,



CHIPS FROM ROUGHING CUT ON A PAIR OF DRIVING WHEEL TIRES.

one for the helper and one for the operator so that both can do their side at the same time and not have to strain themselves or get on their knees to tighten and loosen the tail stock when removing or putting a pair of wheels in the machine. The same wrench at the back of the machine can also be used by helper in loosening or tightening up driving dog clamps, while the wrench on the operator side can be used for the last or hard tightening down or loosening of nuts or studs of the clamps for the tools in the tool post; a shorter handle wrench should be kept for the convenience of the operator for the first or light tightening down or last or light loosening of the tool post stud nuts.

It is of the utmost importance to have the very best kind of driving dogs, and we have found the patented driving wheel lathe dogs known as the "Sure Grip Drivers," which are comparatively small and simple but very efficient, to give the best results. Four of these dogs are bolted on each face plate with only one bolt in each dog, which bolt fits in one of the slots of the face plate, so that it is easy and quick to adjust them to different diameters of wheels when once the face plates have been graduated for these different diameters. A full description of the "Sure Grip Drivers" appeared on page 439 of this journal for November, 1904. With these driving dogs the wheels or tires are clamped solid to the face plate, and the jarring or vibration which occurs when using dogs driving on the spokes of the wheels is done away with. In twelve months time all the expense we have had with them has been to renew the clamp bolts because of some breaking in the threads and some of the heads pulling off.

The question of the tool equipment is one of very great importance and nothing but the very best, toughest, high speed tool steel should be used and here is where a mistake is often made, which considerably reduces the output of the machine, and that is in persistently using too small a size of steel for the sake of economy, for such an equipment is expensive. The new machine to do better than the old one must have tools capable of standing to the capacity or power of the machine, and on such powerful machines you cannot afford to take chances of breaking high price steel which, by breaking, is also liable to damage the machine and in the long run will prove more expensive than to have used the proper size of steel from the start and kept up the maximum output of the machine.

For the roughing out and flange forming tools it is recommended to use high speed steel 1½ ins. wide by 3 ins. deep of the best and toughest kind, and even tools of this size of certain kinds of high speed steel will break. Tools of this size are easy to keep to shape, the nose on the roughing out tools does not flatten so quickly, and it is an easy size to dress to shape. In dressing the tools it is important that the head be not too high over the body of the steel or the operator will loose time in loosening or tightening down the clamps in the tool post. For those who prefer using built-up tools or tool holders for finishing or scraping tools it is advisable that the body of such tools should be made 3 ins. in height or depth, with countersunk head bolts and a recess for nuts, so the tools can be put in and taken out of the tool posts without necessarily unscrewing stud nuts, or, if of smaller size, without adding a liner to make up for the difference in the height.

Figure 1 shows the tool for roughing out the tread and the flange; Fig. 2, the flange (inside) and throat finishing or scraping tool; Fig. 3, the flange (outside or back) finishing or scraping tool; Fig. 4, the tread (flange and blind tire) finishing or scraping tool; Fig. 5, the taper or bevel tool with radius for either flange or blind tire finishing or scraping tools; Fig. 6, is a tool used to remove hard spots on the tread of the tire which cannot very well be taken out with the roughing tool. With such a tool it is possible to get under the hard spot and cut it out or raise it like a shell. With a set of these tools tires can be turned up very quickly and finished very smooth in a short time.

CHIPS FROM FINISHING CUTS. CENTER ONES AT REAR, 1½ INCHES X 3-32 INCH; THOSE ON EITHER SIDE 1 INCH X ¼ INCH; CENTRE ONES IN FRONT 3⅝ INCHES WIDE FROM FORMING TOOLS.

The rate of speed at which the machine can be run depends upon the hardness of the tire; the average cutting speed is about 13 or 14 ft. per minute; it is, of course, necessary to slow down a little when striking hard spots. With soft tires higher speeds may be used. All roughing out of worn tires is done in one cut with an average feed of ¼ in. With this feed, if it is not thrown out on account of hard spots or changing of tools, a blind tire 6½ ins. wide is rough turned in 26 revolutions and about 16 revolutions are required for roughing out the tread of a flange tire 5½ ins. wide.

The different operations are done in so short a time and under such conditions that the attention of the operator is required at his machine all the time and leaves him no time to grind his tools without allowing an expensive machine and equipment to lie idle. The grinding of tools should be assigned to an expert tool grinder, who devotes all his attention to the caring for and grinding of all tools, not only for this one machine but for all other machines in the shop, and it is remarkable the credit which is due to such a man for keeping up the good cutting qualities of the tools, and thus

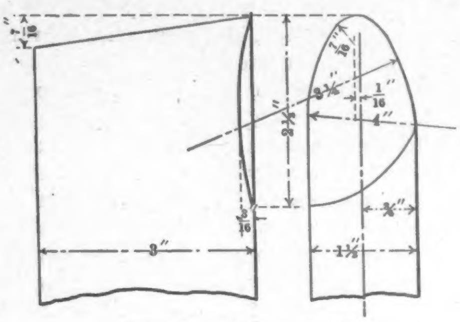


FIG.1 Rouging Tool, Left Hand

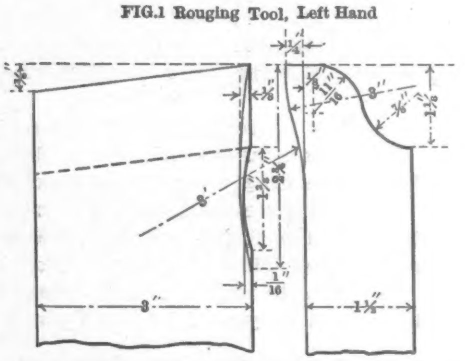


FIG.2 Inside Flange Tool, Left Hand

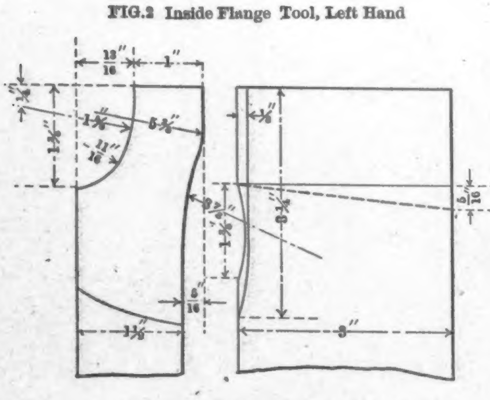


FIG.3 Outside Flange Tool, Right Hand

increasing the output. This man has under him, apart from his assistant, a man whose duty it is to carry the tools to and from the machines.. The expert not only looks after the grinding, but follows up the dressing of the tools done by the blacksmith and also sees to the tempering.

The selection of the proper kind of a man to put in charge of an expensive wheel lathe and equipment is important. He should be ambitious and must realize that the output of the machine will depend largely upon his efforts.

The handling of the wheels in and out of the machine is also of great importance; the time to do this will, of course, vary according to conditions existing in the different shops. A good travelling crane service is necessary to gain the best results. The time given here is for a shop with a travelling crane and is from the time wheels are taken from the cleaning track, which is 100 ft. away from the machine, until they are put into the machine and fastened ready to start the cut; this takes 11 minutes. The time it takes to loosen the wheels after being turned and to remove them from the machine to the storage track, which is 200 feet away, is four minutes. This is the time for the operator and his helper, and during that time the crane and its operator and slinger or crane attendant are used just long enough to carry wheels back and forth, but they do not help to loosen or fasten the wheels in the machine. The time it takes the operator of the machine and his helper to set or change the machine from a certain size of tire to another size is from 15 to 20 minutes.

The helper, in addition to assisting in putting in and taking out the wheels, cleans the axles and paints them with a mixture of white lead and lard oil (a pound of white lead to a pint of lard oil). The strains on the axle while the tires are being turned cause the oil to ooze out of cracks and defects in the axles, are thus located. The helper also keeps the machine and its surroundings clean and removes all cuttings to the scrap yard.

A machine operated under the conditions stated above is capable of turning out five pairs of old 84 in. driving wheel tires in ten hours or six pairs of old 47 in. driving tires in

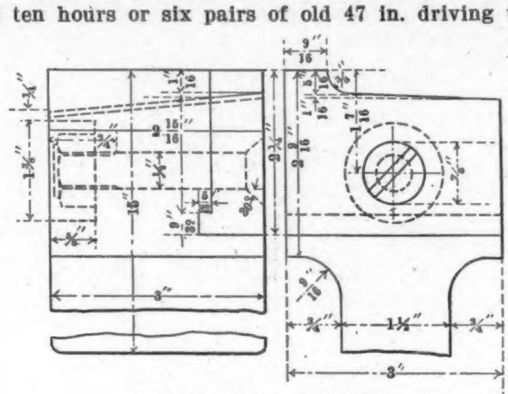


FIG.5 Forming Tool, Right Hand

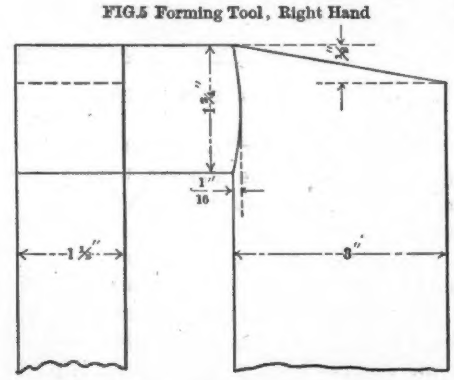


FIG.6

ten hours, or, in other words, will turn out in two days of 10 hours each, three sets of old 57 in. consolidation engine driving wheel tires. On one occasion after the machine was set, three pairs of 69 in. driving wheel tires with flat spots were turned in six hours, a 5/16-in. cut with a ¼-in. feed had to be removed to clean up the flat (hard) or skidded spots and this required, at some parts of the tires, as much as 7/16 of an in. in depth to be turned off. On another occasion three pairs of 63 in., wheels which were not badly worn but had been skidded, were turned in five hours, including the time to set the machine for that size of tire.

Below is given the time it takes for the different operations to turn both flange and blind tires complete.

	Flange.	*Blind.*
Make or Brand	Krupp*	Krupp*
Diameter	69 ins.	69 ins.
Width	5½ "	6 "
To pick up tires from floor and set in mach. ready for cut	11 min.	11 min.
To put roughing tools in and out and rough out tread	42 "	52 "
To put roughing tools in and out and rough out flange (both sides)	22 "	..
To put finishing tools in and out and finish tread..	10 "	15 "
To put finishing tools in and out and finish inside bevel	..	14 "

*All the driving wheel tires used on the Canadian Pacific are of Krupp steel and very hard. This should be kept in mind in comparing this record with that made in other shops.

To put finishing tools in and out and finish flange (both sides)	13 "	..
To put finishing tools in and out and finish outside bevel	9 "	16 "
To loosen wheels and remove them from mach. to floor	4 "	4 "
Total	111 "	112 "

In this case both pairs of wheels were from the same engine; the depth of the cut was 5/16 in. (full) and the feed was ¼ in., and a cutting speed of 13 ft. per min. was used which had to be slowed down over hard spots. It took five sets of roughing tools (10 tools) to rough out these two pairs of tires. This shows plainly what may be done on a modern wheel lathe with good equipment and facilities, for these figures are not of a record run but are of regular daily occurrence. If, in this case, tires had been soft and the roughing out could have been done with two sets of tools (4 tools) as is quite often done, the time could be cut down for both roughing and finishing.

The following is the result of a test made of the motor on this machine which at the time was an a. c. variable speed 30 h.-p., but which has since been changed to a d. c. variable speed 35 h.-p. motor: Diameter of tire 49½ ins., depth of cut ⅜ ins. feed 3/32 in., cutting speed 11 ft. per min., with all resistance cut out, maximum h.-p. 27.6. Diameter of tire 52 ins., depth 3/16 in., feed 9/32 in., cutting speed 16 ft. per min., maximum h.-p. 29.

The accompanying engravings show some of the roughing and finishing chips which were removed and will give an idea of the work such a machine is capable of doing, when operated under the conditions and with the organization and tool equipment described in this article. The use of the forming tools for finishing gives the wheels a remarkably smooth finish.

As a proof that it pays to look into conditions, organization and tool equipment for a new, modern, up-to-date machine it is very interesting to compare what the machine can do now with what it did at first when operated with what was at hand, or equipment from fairly good old machines and before improving the conditions and surroundings and by using the old style dogs driving on the spoke, and tools used on the older machine which had given good satisfaction in the past. Under these conditions the same operator worked as hard, if not harder, and the time it took him to turn a pair of 57-in. tires from the time he picked them off the floor with the travelling crane (which is the same now as it was then) and put them in the machine, turned and put them back on the storage track was as follows:

To pick up tires from floor and set them in machine ready for cut	24 mins.
To machine them complete	2 hrs. 45 "
To loosen wheels and remove them from machine to floor	11 mins.
	3 hrs. 20 mins.

The improvement of conditions, as outlined above, was made possible under the liberal policy advocated by Mr. H. H. Vaughan, assistant to the vice-president, and Mr. H. Osborne, superintendent of shops.

SUPERHEAT AND THE STEAM TURBINE.—The greater advantage of superheat with the steam turbine is well recognized, and steam consumptions of from 9 to 10 lbs. are frequently obtained on the Continent. The results of tests, several of which the writer has at hand, show that the records were made under actual operating conditions in the power plants, some of which, being made under a pressure of 175 lbs. and a superheat of 620 deg. F. at the throttle.—*Mr. Franz Koester, Street Railway Review.*

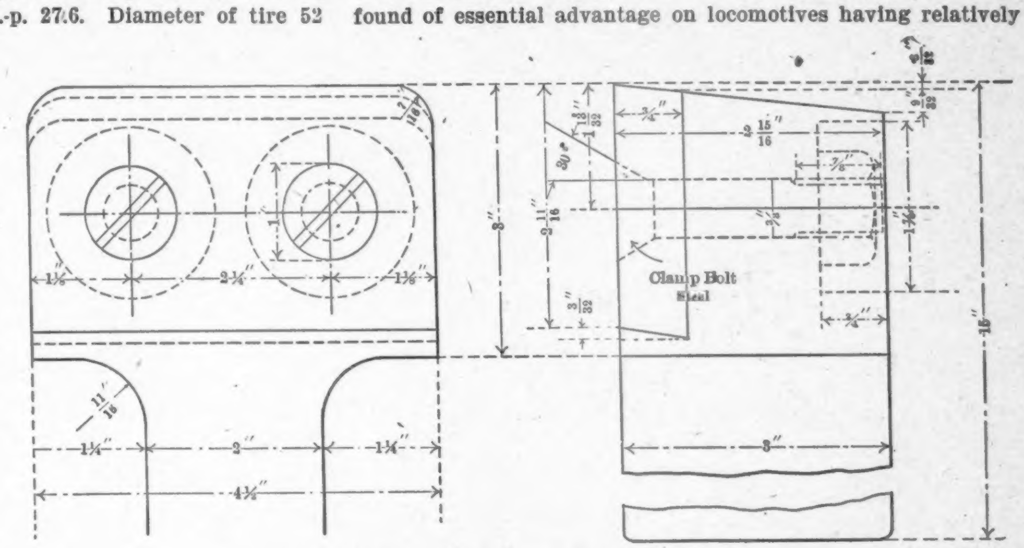


FIG. 4—TREAD FINISHING OR SCRAPING TOOL.

WALSCHAERT VALVE GEAR.*

The Walschaert valve gear was invented by Egide Walschaerts, master mechanic of the Belgian State Railways, about the year 1844, and for many years it has been commonly employed upon locomotives throughout the continent of Europe. American practice has, until recently, adhered, with few exceptions, to the Stephenson link motion, actuated by eccentrics. Experiments were made with the Joy valve gear, following the English practice, but this design has not been perpetuated in America. In the construction of locomotives for export, there has been a more or less continuous demand for the Walschaert gear. Its first use in the practice of the Baldwin Locomotive Works was in the year 1878, upon locomotives for the Mexico, Toluca & Cuantitlan Railroad. This gear has been growing in favor abroad, and, owing to its accessibility and the other advantages set forth in this article, has lately attracted wide attention from American engineers.

For large locomotives where the driving axles are of such diameter as to greatly increase the diameter of the eccentrics, the Walschaert valve gear is particularly useful. It is also found of essential advantage on locomotives having relatively small wheels and engaged in freight service, necessitating a high rotative speed.

The size and arrangement of parts in a modern locomotive make it difficult for an engineer to properly examine the eccentrics and link motion when the engine is on the road, and breakdowns are more frequent on this account. The conditions of service also tend to make it more and more difficult for the enginemen to give the close inspection and care which is demanded in other branches of engineering service with high-speed machines. Stationary engine practice may serve as a guide to those responsible for the successful operation of locomotives, which are even to a greater extent than stationary engines, high-speed machines. With the Walschaert valve motion only a single eccentric or its equivalent is necessary for each valve. As usually constructed, it is found more convenient to substitute a return crank, thus reducing the pin bearings to the smallest possible diameter, so that they may be readily lubricated, and, owing to the small amount of work they have to do, give satisfactory service and absolute freedom from heating.

So far as the distribution of steam in the cylinders is concerned, the constant lead, which is a feature of this motion, is not considered objectionable, and it has some distinct advantages. Under such conditions it is possible to determine upon the amount of lead the engines should have at the most economical point of cut-off. This point determined, and so designed, it cannot be altered by any one in the shops or roundhouses. Another advantage is that it prevents valve

* From a Baldwin Locomotive Works pamphlet.

setters from attempting to produce results by moving the eccentrics into improper relations one to another.

The constant lead of the Walschaert motion prevents the sealing of the cylinders by the piston valve when the piston is at the end of its travel or approaching it; whereas with the link motion, either by derangement or excessive wear, the valve laps the ports at the end of the stroke, thus causing excessive compression and many other troubles. Another feature of the motion which appeals to the engineer, is the ease of handling the reverse lever when the locomotive is running at a high rate of speed.

GENERAL INSTRUCTIONS.

In setting the Walschaert valve gear it must be borne in mind that two distinct motions are in combination, viz.: the motion due to the cross head travel, and the motion due to the eccentric throw.

The crosshead motion controls the lead, by moving the valve sufficiently to overcome its lap, by the amount of lead in both front and back positions. The eccentric throw controls the travel and reversing operations. It will be seen that the movement due to the eccentric, without the crosshead motion, would place the valve centrally over the ports when the piston is at the extreme end of the stroke. The combined effect of these two motions, when the parts are properly designed, gives the required movement of the valve, similar to that obtained by the use of a stationary link. To reverse the engine, the link block is moved from end to end of the link, instead of moving the link on the block. This operation is accomplished by means of a reversing shaft connected with a reversing lever in the cab.

Walschaert gears should be correctly laid out and constructed from a diagram, as the proportions cannot be tampered with by experimental changes without seriously affecting the correct working of the device. The only part capable of variation in length is the eccentric rod, which connects the return crank with the link. This rod may be slightly lengthened or shortened, to correct errors in location of the link centers from center of driving axle which carries the return crank.

The eccentric usually assumes the form of a return crank on one of the crank pins—and its center is at right angles to the plane of motion, viz.: at 90 deg. to a line drawn from the point on the link at which the eccentric rod is attached, through the center of the driving axle. This eliminates the angular advance of the eccentric, and allows the use of a single eccentric for both forward and backward motion. The throw as specified must be correctly obtained, and great care taken that the position shown in the design be adhered to. The crank representing the eccentric is permanently fixed to the pin, and the slightest variation will be detrimental.

When the engine is assembled, the throw of the eccentric should be checked up by the specifications, and any error should be at once reported in order that the mistake may be rectified by either correcting the position of the eccentric, or by a change in the design of the other parts to compensate for the error.

In addition to the above instructions, the pamphlet contains special instructions for erecting and setting the valves and closes with the following simple additional check, which should be made to see that the valves are properly set:

Set one side of the engine so that piston is at its extreme forward position in cylinder, and check lead on admission port. In this position it should be possible to move the link block through its entire travel in the link, without in any way disturbing the movement of the valve. This operation should then be reversed, and the other side of the engine similarly tried with the piston located at its extreme backward position in the cylinder.

SOME OF THE ESSENTIALS IN LOCOMOTIVE BOILER DESIGN.

Mr. David Van Alstyne, mechanical superintendent of the Northern Pacific Railway, in a paper on the above subject read before the Northwest Railway Club on January 9, makes several suggestions tending toward the improvement of boiler design and the reduction of the large amount of trouble given by the boilers which are at present in operation. Mr. Van Alstyne has given this subject a great deal of study and the suggestions that he makes are the result of careful thought, guided by long experience.

The following extracts, taken from this paper, cover the main points suggested:

"Reliability and low cost of maintenance depend chiefly upon freedom of circulation around the firebox. Since circulation depends upon the head creating it and the size of the passages through which the water must flow from the barrel of the boiler to water legs around firebox, it follows that the greater the depth of firebox and the wider the water legs the more rapid the circulation. This depth should be obtained by maximum depth of throat sheet and not by raising the crown sheet at the expense of steam space."

"The greater the length of the firebox the greater the volume of water required to pass from the barrel of the boiler into the water legs, hence the side sheets and staybolts of a short firebox are less likely to give trouble than a long one. The tendency, therefore, should be toward a decided increase in depth of throat and width of water space and as short a firebox as is consistent with necessary grate area. The result will be an exceedingly heavy and bulky boiler at the firebox, necessitating the use of trailer truck which, it is likely, will eventually have four wheels instead of two."

"With reference to flues, considerable observation leads me to believe that a comparatively wide bridge, say, one inch or possibly more, is desirable for large boilers because of the greater stiffness of the flue sheet and probably better circulation between flues. But wide spacing does not cure leaky flues, which are the most difficult boiler trouble to control. The length of flue, quality of water and coal, method of firing and working injectors, weather and severe service, all have an influence on the leakage of flues, and this influence is, I believe, exerted chiefly through their effect on the size of the nozzle. Whatever causes, therefore, have the greatest tendency toward reducing the nozzle would be the most productive of leaky flues, and these I believe to be poor coal and severe service. So far as my investigation goes, the great majority of leaky flues are below the center line of the boiler, indicating that the short flames of highest temperature enter the lower flues. Hence the need for the greatest possible depth of firebox below the flues so that these hottest flames cannot reach them."

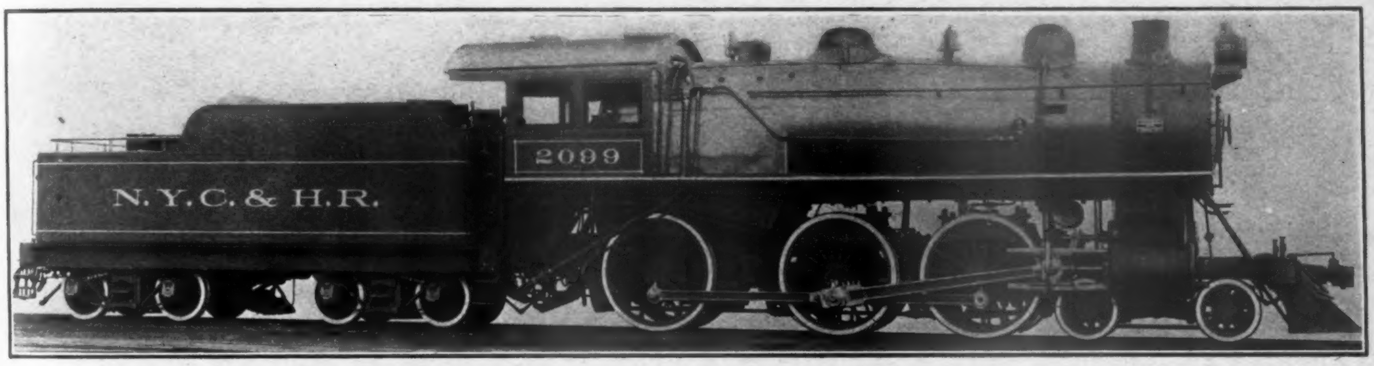
"Any other means of keeping the most intense heat away from the flue ends will have the same good effect on flue leakage, and recent experience with a combustion chamber which sets the flue sheet three feet ahead of the throat sheet has shown a marked decrease in flue leakage. Of utmost importance, however, is the care of boilers. The most poorly designed boiler is made better by more care, while the best designed boiler will not do well if neglected, and some of the important features in good care of boilers are regular and thorough washing out and blowing off, washing out and filling up with hot water, uniform boiler feeding and avoidance of working injectors as far as possible when the engine is not working steam, removal of broken staybolts promptly, and intelligent expanding of flues. Water treatment has done much to reduce boiler troubles, but it has its limitations and, in my judgment, should not be attempted until the possibilities of design and systematic maintenance have been exhausted."

"To sum up, it seems to me that the locomotive boiler in its fullest development will be much larger and heavier in proportion to the barrel than it is now. It is quite likely that it will be necessary to carry the overhanging weight back of the drivers on a 4-wheel truck."

"I think that it is not overdrawing it to say that no heavy

road engine should be built with weight on drivers more than 70 per cent. of the total weight, and the lower this percentage is the more reliable and efficient the engine will be, it being understood, of course, that as much of the dead weight as possible is put into the boiler."

An outline diagram of a Pacific-type locomotive was presented with the paper, which incorporates principles considered by the author to be of importance. This engine included a combustion chamber 6 ft. long ahead of the firebox and contained 374 2-in. tubes 16 ft. long. The water space in the throat was 8 ins. at the mud ring, and at the sides it was 6 ins. at the mud ring and widened to 12 ins. near the crown sheet. The combustion chamber was set 15 ins. from the barrel of the boiler at the bottom. This was a 22 by 28 in. engine having 78-in. drivers, giving a total of 150,000 lbs. weight on drivers and 250,000 lbs. total weight. The throat sheet was longer than usual, placing the grate as far below the combustion chamber as possible. The heating surfaces were, tubes 3,133 sq. ft., combustion chamber 121 sq. ft., firebox 213 sq. ft.; total 3,572 sq. ft. The grate area was 48 sq. ft.



4—6—0 FREIGHT AND PASSENGER LOCOMOTIVE—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

10-WHEEL FREIGHT AND PASSENGER LOCOMOTIVE.

NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

The New York Central & Hudson River Railroad has just received fifteen 10-wheel locomotives from the American Locomotive Company, which were designed under the direction of Mr. J. F. Deems, general superintendent of motive power, and are adapted to handle either passenger or fast freight trains. The freight trains on the Hudson River Division are operated at a comparatively high speed, and in addition to this service these engines will probably be used to a large extent, especially during the summer months, in handling the heavy excursion passenger business. The following table presents a comparison between these engines and the Pacific type engines used on the New York Central, which have given excellent results.

	4-6-2	4-6-0	Advantage. 4-6-2	4-6-0
Weight, total engine	222,000	194,500	14.2%	....
Weight, total engine and tender	355,000	338,400	5.0%	....
Tractive power	28,500	31,000	....	8.8%
Grate area	50.2	54.93	....	9.4%
Total heating surface	3633	3306	9.9%	....

The 4—6—0 locomotives weigh considerably less but have a greater tractive power and a larger grate area than the 4—6—2 type. The latter type, however, has a larger heating surface, which probably accounts for their ability to carry heavy trains at sustained high speeds. The 4—6—0 type should prove very satisfactory for trains where long sustained high speeds are not required. The leading dimensions of these engines are as follows:

TEN-WHEEL FREIGHT AND PASSENGER LOCOMOTIVE—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Fast Freight and Passenger.
Fuel	Bituminous coal.
Tractive power	31,000 lbs.
Weight in working order	194,500 lbs.
Weight on drivers	148,000 lbs.
Weight on leading truck	46,500 lbs.
Weight of engine and tender in working order	338,400 lbs.
Wheel base, driving	15 ft. 10 ins.
Wheel base, total	26 ft. 10½ ins.
Wheel base, engine and tender	59 ft. 2 ins.

RATIOS.

Tractive weight ÷ tractive effort	4.77
Tractive effort x diam. drivers ÷ heating surface	647.
Heating surface ÷ grate area	60.1
Total weight ÷ tractive effort	6.27

CYLINDERS.

Kind	Simple.
Diameter and stroke	22 by 26 ins.
Piston rod, diameter	4 ins.

VALVES.

Kind	12 in. Piston.
Greatest travel	6 ins.
Steam lap	1 in.
Exhaust lap clearance	¼ in.
Setting, line and line full forward motion	¼ in .lead at ¼ cut off.

WHEELS.

Driving, diameter over tires	69 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	9½ by 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6¼ by 10 ins.

BOILER.

Style	Extended wagon top.
Working pressure	200 lbs.
Outside diameter of first ring	72⅛ ins.
Firebox, length and width	105⅛ by 75¼ ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	3½ and 4 ins.
Tubes, number and outside diameter	400 2-in.
Tubes, gauge and length	11, 14 ft. 11 in.
Heating surface, tubes	3,104.5 sq. ft.
Heating surface, arch tubes	26.4 sq. ft.
Heating surface, firebox	174.6 sq. ft.
Heating surface, total	3,305.5 sq. ft.
Grate area	54.93 sq. ft.
Exhaust pipe	Single nozzle, 5⅜, 5⅝ and 5⅞ ins.
Smokestack, diameter	20 ins.
Smokestack, height above rail	14 ft. 7 9/16 ins.
Centre of boiler above rail	115 ins.

TENDER.

Tank	Water bottom with gravity fuel slides.
Frame	13 in. channels and plates.
Weight, loaded	143,900 lbs.
Wheels, diameter	36 ins.
Journals, diameter and length	5½ by 10 ins.
Water capacity	7,000 gals.
Coal capacity	12 tons.

AN AUTOMOBILE TESTING PLANT.

Purdue University, at Lafayette, Ind., has recently installed an automobile testing plant. The design of the plant has been worked out under the general direction of Dr. W. F. M. Goss, Dean of the Schools of Engineering, assisted by Professors J. R. McColl and W. O. Teague. It follows lines similar to those of a locomotive testing plant, and constitutes a mechanism upon which an automobile of any type, whether steam, electric or gasoline driven, may be mounted and operated, and the power delivered, as well as the efficiency, may be determined.

The automobile, when mounted for testing, has its driving wheels carried by supporting wheels, which are upon an axle revolving in fixed bearings, the front wheels resting on a platform level with the top of the supporting wheels. Thus mounted, the automobile is held in its desired position by a connection with a traction dynamometer at the rear of the machine. A friction brake on the axle of the supporting wheels absorbs the energy delivered by the machine. A motor-driven pressure blower delivers air through adjustable piping for cooling the radiators of steam and gasoline machines, and a motor-driven exhauster takes air from a point near the exhaust of the machine, thereby freeing the laboratory of obnoxious gases.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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Some railroad men say that they have no time to read technical papers. With all modesty this may be pronounced an unqualified mistake, because much valuable time may be saved by a proper study of technical literature. A young motive power officer was promoted chiefly because he did read the technical papers. He had found them valuable and made use of them in the office while occupying a position requiring long hours and constant application, but in the new position found that he was really too busy to read the papers as he did formerly. Therefore he adopted a plan which is worthy of the attention of others. He requires certain of his subordinates to read various journals, and to read them so thoroughly as to be able to place before him brifly the facts requiring his attention. Sometimes this was verbal and sometimes written, but in this way this official is sure to know of everything valuable which appears in print in connection with his work, and his method also requires the same knowledge on the part of others.

The effect of tonnage rating improvements on one of the western lines was recently investigated by an operating official, in a way to determine the results, which had been obtained by a careful study of the loading of locomotives. The purpose was to adjust rates previously put into effect, which in some cases were found to be producing delays in traffic due to over-loading. In some cases the rates were known to be slightly too low. This revision resulted in rather extensive changes on four divisions, by increasing some rates and decreasing others, the net result on one division was an increase of 19 per cent. in ton mileage; on the second division the increase was 9.1 per cent., on the third division 3.8 per cent. and on the fourth 27 per cent. The tonnage rates had in some cases been quite a little too high and in other cases were not changed. This experience indicates the desirability of an occasional review of this subject, because of the difficulty, if not impossibility, of determining tonnage rates at one time which would be good for all times and for conditions which are continually changing even if changing but slightly.

ANOTHER WORD TO COLLEGE MEN.

In recent discussions concerning college graduates and regular apprentices on our railroads much has been said about special apprenticeship. Those who believe that special apprenticeship of technical college graduates does not meet the present need are increasing in numbers. The question has risen as to how college men should be brought into railroad service, if not through special apprenticeship.

There are two ways to provide technically educated men in railroad service, one is to select promising young men from the ranks and provide technical education for them after having shown in practical experience their aptitude for railroad work. The other way is to take a young man into the service after graduation. If special apprenticeship is not the best thing for the latter, what then?

In the interest of these young men and in the interest of the roads the suggestion has been offered that the young men should begin in the shops, in the roundhouse or on a locomotive, at some point where men are wanted, that they should secure a position exactly as any other men secure positions by applying for it and being tried in order to ascertain their fitness. In the application for the position both the employer and the employee can well afford to forget the matter of education and its possible effect upon the qualifications of the applicant. When once in the service and standing squarely on his own feet, the education will help the young man in his career, and if he has selected his lifework wisely, and he is of the right sort, he will probably advance very much more rapidly than in special apprenticeship. This suggestion has been made in these columns before. It is not in any sense novel, but its reiteration seems necessary, because of the rather prevalent opinion that there is no other and better way for a college man to take up railroad work than that known as special apprenticeship.

SHOP EQUIPMENT AND OPERATION.

It is not difficult to interest railway officials in shop plans and shop buildings. Very valuable records of this portion of the shop subject are available, and it is comparatively easy to secure opinion and develop discussion of the relative merits of different arrangements. The fact, however, is becoming appreciated that many of the large important shop plants have been disappointing in the results of operation. Railroads are coming to realize that a modern shop involves a very large construction expense, but they have yet to realize that even of greater importance is the adequate development of the equipment and perfection of organization required to operate the large shop.

It is one thing to build a shop, and quite another thing to build it on a large scale in such a way as to decrease the cost of repairs. The matters of equipment and operation constitute a problem which comparatively few are able to discuss, for the reason that the shops, buildings and arrangements have themselves been so difficult to provide that there has not been sufficient time to properly consider equipment and operation. It is well to provide buildings sufficiently large and well arranged, and the time has now arrived for dealing with the remaining problem of what to put into the shops and how to manage them. This is a field to be tilled without the advantage of precedent, because only recently has the importance of commercial management and commercial production in railroad shops been appreciated.

It must be admitted that salaries in railroad shops have been conspicuously inadequate, but this is already beginning to change, and a brilliant future is held out to the men who are now prepared to take the responsibility for the operation of

the large modern shops in which so much money is invested. The railroads are not likely to be slow in securing adequate shop organization for plants which have cost them from one-half million to two million dollars. With the realization of what the large shops mean as an investment will come the means for utilizing them to the utmost, and it may now be confidently stated that young men who prepare themselves during the next few years to competently superintend railroad shops will be in greater demand than ever before. There are satisfactory indications that very soon superintendents of large shops will receive as high salaries as superintendents of motive power of moderate size roads received ten years ago.

STANDARD LOCOMOTIVES.

The adoption of standards for locomotive and car construction on large railway systems has developed a fact which is likely to become important. In the days of small railroads the individual ideas of the motive power officials were shown in a marked and distinctive way in the form of peculiarities in their cars and locomotives. While this tendency toward fads had its disadvantages, the locomotives and cars with these fads, and representing individual ideas, possessed the advantage of having the personal attention of the originators of the ideas and the personal interest of the officials responsible for them often led to a successful use of factors of design which in themselves perhaps did not possess great inherent value.

Now that roads have combined and the motive power questions are often decided by general officials the importance of standardizing is becoming appreciated. This standardizing movement is likely to have one effect to which attention has not yet been called. The danger is in adopting a standard of locomotive, or a series of standards, that these standards will be nobody's babies and that they will not represent the personal ideas or opinions of anybody, and no one on the road, not even the general head of the motive power department, will be the father of the design. It is much better that some one's individual opinions should be embodied in standard locomotives, even if those opinions be not the best, rather than that the standards should be the result of cutting and fitting, producing a weak, characterless combination of factors which represents what every one considers least objectionable. Such a standard as this would be inert in the sense that no single individual on the road is interested in its success because it does not represent any individual opinion and no one is prepared to stand up for it and make it successful. A standard locomotive under these circumstances is like one used in a pool, is like a shovel or a pick, and represents no individuality. It is something to be taken up and used and laid down again for some one else to take up and use.

Careful thought upon the possible effect of this leads to the conclusion that some one on every railroad must deal with the locomotive problem with a firm hand, and if any department of the road requires the hand of authority and responsibility it is the motive power department. The desired results will not be obtained until the present general superintendent of motive power on the large systems of roads is taken into the council of the higher officials and made a vice-president in charge of motive power. This official may then assume absolute authority and stand upon the results of his opinion as shown by the records. The locomotive is too important a factor in railroad operation to be successfully handled in any other way, and the time must soon pass when anybody and everybody may have a hand in influencing the design of locomotives. Much will be gained by appointing a vice-president in charge of motive power with the understanding that he should put into effect his ideas as to locomotive design. With a strong hand supported by wide experience and a knowledge of what is wanted and what is best he would be in an ideal position to do that which is needed

SHOP BETTERMENT AND THE INDIVIDUAL EFFORT METHOD OF PROFIT-SHARING.*

BY HARRINGTON EMERSON.

The employe wants as high wages as he can get. The employer wants his output to be as cheap as that of his competitors, for, if it is not, he will soon have to shut down his shop. Both desires are reasonable, and the problem is to reconcile them without injustice to either party. An absolutely clear understanding by both parties of the shop problem of to-day is necessary: the shop problem of to-day, not of years ago, when conditions were very different; not of years hence, when conditions no one can now foresee may prevail.

The worker cannot be expected to work for one employer for less pay than is paid under similar conditions for the same work by another employer. The wage-payer will not pay higher wages than the current rate, or than business conditions permit. There may be, however, quite a gap between the wages paid by competitors and the higher wages the employer would be willing to pay if it can be proved to him that it is to his advantage to do this. Wages above the current rate cannot therefore be agreed on in advance of performance, but should result from individual effort.

It is to be made plain to the employer that not by an increase of expense, but by a readjustment of expenditures, he can with advantage to himself give higher pay than the average; and it is to be made plain to the wage-earner that the receipt of higher pay must depend on his own individual character, skill and effort. Up to a certain point, competition and combinations can force wages up, sometimes generally, sometimes only locally and temporarily; but beyond this point there is a possibility of higher than the average pay, to be brought about only by recognition of the fact that the higher rate is to the advantage of both wage-payer and wage-earner. To illustrate the conditions of shop operation as they exist to-day, an example is afforded in the cost statement of a large machine shop in an eastern state.

COSTS OF OPERATION FROM JANUARY 1ST TO AUGUST 31ST, 1905.

Costs of Materials	$172,916.40
Wages paid to direct labor	$ 49,174.98
General Expenses	$ 90,698.54
	$312,789.92

OUTPUT 500 ENGINES, COSTING EACH—

		Per cent.
For material	$345.83	55.3
For direct labor	$ 98.23	15.7
For general expenses	$181.50	29
	$625.56	100

"Day wages" are less than one-sixth of the whole expense; "general expenses" more than twice as much as labor, and "material" more than half the total expense. The question was this: What can we do to reduce the cost of manufacture, so as to compete with our rivals?" To answer this question, the first step was, not to look at the plant, but to examine the accounts. In a plant a very small item may seem important, as when fault is found with some visible steam leak, but the big waste, as the condensation taking place in some buried pipe, is not noticed. But in the accounts, matters entirely overlooked by shop officials, yet making all the difference between success and failure from a business point of view, may at once become apparent. The condensed statement of cost of operation at once shows that materials are more important than general expenses, and these in turn are more important than labor costs. The three items of expense of this particular machine shop must first be more clearly defined.

COST OF MATERIALS.—This is the money paid out for materials bought wherewith to make the engines. It includes *all* the cast-iron, *all* the brass, *all* the steel, *all* the fittings, less the scrap value of material not used. If a high-priced casting is secured and spoiled in the machining, this becomes part of the cost. If a casting weighing 100 lbs. is paid for and machined down to 20 lbs., the whole 100 lbs. are included in the

* Prepared for distribution on the Santa Fe.

cost. If fittings are ordered and not used, if they are lost or stolen, if patterns are changed so that parts already cast can no longer be used, all these items enter into cost of materials. It is evident that very much material has to be paid for which never goes out on the finished engine.

COST OF DIRECT LABOR.—Direct labor is the wages of those men who work directly on the machines to be sold. The labor of the machinist or of the fitter is considered direct labor, but the labor of the foreman or engineer, of the timekeeper, of the watchman, is not considered direct labor, but is taken care of as part of general expense. All direct labor does not, however, go into the machines that are sold. There is a very large shrinkage. If a casting is partly machined and has to be thrown away, the labor put on it is lost; if a man waits an hour for work, or for crane service, or studies an hour over a poor blue print, the money paid for his time is lost. If a man's machine breaks down, if his belts slip, if his tools are of poor quality, if the cast-iron is hard, if his machine chatters, if in consequence he takes twice as long a time as he would like to give to the work, half his time is lost, but has to be charged for in the cost of the engine.

GENERAL EXPENSES.—This includes many items, and first, wages of all employes whose time cannot be directly charged to a definite engine. The pay of all the officials, of all the bookkeepers and timekeepers, of all the foremen, of all the general force, as engineer, fireman, carpenter, millwright, watchmen, wipers, laborers, is part of general expense. Rent, insurance, taxes, repairs to buildings and machinery, depreciation of buildings and machinery, all small tools, belts, oils, and other supplies, all costs of power, heat, light, water, are some of the other items making up general expense. In the example given above, only the costs to the factory door are included, and not any allowance for advertising, for selling, for general offices and agencies, for bad debts, for finished machines that cannot be sold, etc. The question was not one concerning the management of the business, but solely concerning factory costs.

INCREASING COSTS BY DECREASING PAY.—When factory costs are found to be too high, the usual plan is to propose a reduction of wages, chiefly because the payroll is the plainest and most insistent item of recurring expense, and also because any bookkeeper can reduce a payroll in a few minutes; but it takes long, intelligent planning and persistent effort to lessen the losses due to materials and to inefficient general management.

The results of reducing wages will first be considered in the case cited. If wages are reduced 10 per cent., the best men will leave; those who stay will be angry and discontented, becoming hostile and discouraged; and, those who are employed to take their places will be slow and unskilled. Less work will be done, and more material will be wasted and spoiled. It is safe to assume that for the same number of men and same amount of material 10 per cent. less engines will be turned out. More foremen will also be required to teach and direct the inferior men, and there will be no chance to save on taxes, insurance, and other similar items. The account will therefore stand:

Materials	$172,916.40
10 per cent. less wages paid to direct labor	44,257.48
General Expenses	90,698.54
	$307,872.42
An apparent saving of	4,917.50
	$312,789.92

But if we consider output, another story is told.

OUTPUT 450 ENGINES, COSTING EACH:

		Per cent.
For Materials	$384.26	56.2
For Direct Labor	98.34	14.4
For General Expenses	201.55	29.4
	$684.15	100

Put the two results side by side:

Cost before wages were reduced.	Per cent of direct labor.	Cost after wages were reduced.	Per cent of direct labor.
$625.57	15.7	$684.15	14.4

By reducing the amount paid direct labor the manufacturer has reduced his output, and his other costs for each engine have increased $58.58, or nearly 10 per cent. This is evidently not the way to go about it, as it harms not only the wage-earner but also the wage-payer. As any poor method must harm both employer and employe, so a good method should benefit both employer and employe; and there is such a method.

HOW TO LESSEN COSTS BY INCREASING PAY.—The desirable method is the one which lessens the cost of production to the employer yet increases the reward of labor. One of the names given to it is "shop betterment." Shop betterment is based on careful examination of details, of methods, materials, machines and men employed in shop production, and on the elimination of all unnecessary wastes and losses of material or of effort and time. Shop betterment takes into account the three items of expense and the final cost of each engine.

Cost of Materials	$172,916.40
Wages to Direct Labor	49,174.98
General Expenses	90,698.54
	$312,789.92

OUTPUT 500 ENGINES, COSTING EACH:

		Per cent.
For Material	$345.83	55.3
Direct Labor	98.35	15.7
General Expense	181.40	29
	$625.58	100

The largest of these items is cost of materials; the smallest, wages of direct labor. It ought to be easier to save $5,000 out of $172,916 than to save $5,000 out of $49,174. Moreover, a manager may have trouble on his hands if he tries to cut direct labor, while no one should object if he can save some of the wastes in his materials.

REDUCING COSTS OF MATERIALS.—In materials much can always be done. Designs can be bettered so as not to require so much or so expensive materials. A light, high-speed stationary engine will furnish just as much power as a heavy, slow engine. Patterns can be made a little closer to finished sizes and castings be specified of soft, sound iron, and be pickled before being machined, thus lessening the time required. By these means 5 per cent. might be saved on material, and 5 per cent. on $172,916 is $8,645.80; while 10 per cent. reduction in wages would amount to only $4,917.50.

REDUCING GENERAL EXPENSES.—The next item to look at is general expenses. This might be reduced somewhat if fewer foremen, watchmen, timekeepers and bookkeeprs, tool dressers, repair men, were required; and fewer of these men are required for good workmen than for poor. The best way, however, to reduce the percentage of general expenses is to increase output, as the larger part of general expense remains the same whether 10 or 1,000 engines are made. To increase output the employer puts his machines in good repair, lines up his shafting, renews and maintains his belting, puts in emery wheels, stops up the air and steam leaks, increases his air pressure, puts up better drawings, supplies better small tools, dresses and tempers and grinds them better, secures jigs and special devices, and makes it possible for the worker with less exertion than formerly to turn out considerably more work.

REDUCING COSTS THROUGH CO-OPERATION.—The employer who aims to reduce costs by saving in materials and in general expenses first puts all his equipment and supplies in good condition, and then goes to the workman and tells him that if he will co-operate to cut out unnecessary losses and wastes, if he will make good use of the better facilities afforded him, it will be possible to increase the amount paid him. Let us assume that on the average the increase of pay amounts to 20 per cent., and that the output is increased 20 per cent., but that materials increase only 10 per cent., and general expenses not at all, how does the account then stand?

Materials	$190,208.04
Direct Labor	$ 49,174.98
Average Increase, 20%	$ 9,835.00
General Expense	$ 90,698.54
	$339,916.56

OUTPUT OF 600 ENGINES, COSTING EACH:

		Per cent.
For Material	$317.01	56
For Direct Labor	$ 98.35	17.4
For General Expenses	$151.16	26.6
	$566.52	100

The employer pays his men 20 per cent. more, and by all sorts of shop betterments, which cost a great deal to install and maintain, he enables them to obtain 20 per cent. more output from the machines in the same time and without any more exertion to themselves; yet, owing solely to the cutting out of useless wastes, the output costs 9 per cent. less. This 9 per cent. is the employer's gain. The method is one that benefits both wage-payer and wage-earner. Each, independently, has worked to reduce losses and wastes of materials, of supplies, of operation, of time, and they both share in the gain. This system of profit-sharing has been rightly called

THE INDIVIDUAL EFFORT SYSTEM,

because it depends on the individual effort of both employer and employe. The former does not arbitrarily reduce wages, for he has found a better way to economize, and the latter does not arbitrarily make demands for increased pay, for he has already increased his own pay far above the rate any employer would grant. Irrespective of the individual effort gain, they both, at the time the wage-earner is employed, enter into an agreement or contract as to regular wages. This contract wage may be changed from time to time as conditions change; but whether it rises or falls, it has nothing to do with the profit-sharing plan of individual effort. The employer must exert his individual effort to make all conditions of production as good as possible, and these include the comfort and well-being of his employes. The employe must exert his individual effort to do his best under the conditions afforded.

THE PAY FOR INDIVIDUAL EFFORT.—As the method is one of individual effort, a practical way must be found of rewarding the individual worker in addition to and regardless of regular contract wages. The method adopted has long been in use in paying engineers and firemen on the railroads of the United States. It was thought that no better method could be devised than one adapted from such a model, and satisfactory to men of such skill and standing among the employed. In operating trains the employer makes the roadway, maintains the track, furnishes the engines and trains, installs the system of signals, makes out a time schedule, appoints a dispatcher, and then gives the train to its crew. The ability to make the schedule depends on the conditions furnished by the employer and on the diligence and skill of the crew. The latter are expected to make the schedule, but if they fail through any fault not their own, they receive time pay although the train stands still; and if for any reason they make extra effort, run more miles than the schedule calls for, they are paid for the extra miles.

As far as possible this system has been adapted to the machine shop. A schedule is made out, a reasonable standard-time is set, such as any skilled man ought regularly to make, a schedule on which any good foreman ought to insist. For doing work in standard time the wage-earner receives 20 per cent. increase of pay above the hourly rate. He is paid this extra 20 per cent., not to work beyond reason, but to use his brains as well as his hands, to be his own foreman, to help keep conditions as they should be, to assist the employer in maintaining high efficiency in tools and machines.

If for any cause whatever he does not maintain schedule standard time, he is still paid an extra amount until time-and-a-half has been used on the job. If he falls below time-and-a-half, he still receives his regular hourly rate, which is never interfered with. If, however, he does better than standard time, then he is given all the gain due to his own time. If standard time is 1 hour, if the rate is $0.25 an hour, if the extra pay is $0.05, making a total of $0.30, then, if the work is done in one half-hour the wage-earner is paid $0.30 for one half-hour's work, or at the rate of $0.60 an hour. If, however, he takes 2 hours on the job, he receives $0.50, or at the regular rate of $0.25 an hour. This shows why it is possible by unusual and extraordinary effort to earn a large extra amount.

This method of profit-sharing, of rewarding individual effort of both employer and employe, is utterly different from piecework, with which those who have not investigated it have confounded it. In day work the employe is paid for his time, and he gets the same wages whether he works extraordinarily well, badly, or not at all. In piecework the employe is not paid for time, but for output. He takes all the risks of conditions over most of which he has no control, and if he seems to make too high wages the rate is often cut. Under the individual effort system the wage-earner is guaranteed his regular hourly rate irrespective of output. It is the foreman's duty as well as his own to avoid unnecessary delays. His hours are definite both as to beginning and end; his nights and Sundays are his own, and overtime being recognized as an evil to both employer and worker, it is eliminated as far as possible, the employer being forced to pay time-and-a-half for every extra hour. Wage-earners have contended for shorter hours, yet with opportunity to earn regular rates of wages. Under the individual effort system a man can work eight hours, yet earn as much as he formerly earned in ten hours.

NO PIECE RATE.—Because there is no rate by the piece, men may receive the same increase above normal wages for turning out different amounts of output. Each must do well, and this is all that is asked. One man may have a good machine, another a poor one; one has a hoist, and the other none; so the latter is allowed twice as much time and twice as much pay for his output as the former.

CUTTING THE RATE—But what is to prevent the employer from cutting the rate? Cutting *what* rate? The day rate has nothing to do with the individual effort reward, and if the day rate is cut the worker can resist, as he has always done. Cutting the standard time? The standard is a fair time, adapted to conditions. If conditions change for the worse, the schedule time should be extended just as time cards of trains are lengthened when the track conditions are bad; and if the conditions are improved the schedule is shortened just as time cards are shortened when all track conditions are bettered. If a man has been working on a $1,000 wheel lathe on which the best he could do was a pair of drivers in four hours, and he is given a $10,000 wheel lathe on which he can just as easily turn the same pair of drivers in an hour and a half, of course he receives a different schedule; but it is still as easy, probably easier than it was before, to earn the 20 per cent. extra each hour. The worker is paid 20 per cent. extra, not for doing so much work, not for turning out so many pieces, but for making good use of the conditions, whatever they are, and making his head save his hands.

He wants to know, however, what is to prevent the employer from arbitrarily reducing standard time so that it will be impossible to earn 20 per cent. extra. The answer is that self-interest stands in the way, the self-interest of the employer, and this is the strongest protection of the worker. Nothing compels the employe to try to make standard time. If he does not think he is treated fairly, he will not put forth the same effort, and the employer loses far more than he does. The schedules are intended to be as fair as they can be made. If found not to be fair, they should be revised and adjusted in the interests of both parties. For example: Standard time of turning locomotive drivers, four hours; man's rate, $0.30; extra pay per hour, $0.06; general expenses per hour, $0.60.

THE COST AT 4 HOURS:

Wages	$1.20
Individual Effort Reward	.24
General Expenses	2.40
Total Cost	$3.84

The employer reduces standard time to three hours, and the employe drops back to five hours. He can just as well do this, for he would make nothing extra at his former time of four hours.

TOTAL COST AT 5 HOURS:

Wages at $.30	$1.50
Individual Effort Reward	——
General Expenses	3.00
Total Cost	$4.50

Because standard time has been cut, the employer loses \$0.86 and the wage-earner loses \$0.30. The proverb says any one can lead a horse to the trough, but it takes a wise man to make him drink. The employer can do his share, but all his trouble and expense will be in vain unless he can induce the wage-earner to co-operate; and the cheapest, easiest method to secure and maintain co-operation is to offer an attractive increase of pay. Under no other system can the employe so effectively protect himself.

Standard times for each operation are determined by a careful study of all the conditions and a try-out, itemized in minutes and seconds. The try-out is not with stunt or pace-making labor. The economies are effected by cutting out wastes, not by demanding extraordinary or unreasonable output. Is it the practice to discharge men who cannot reach standard time? No. If a man cannot reach standard time, it is for one of three reasons: either standard time is too low, in which case it is corrected; or the machine and equipment conditions are not right, and should at once be improved; or the worker does not know how, is not up to the machine operation, in which case he is changed to some other place. If a worker deliberately makes up his mind that he will not give a fair return for his wages, if after changing him around several times and giving him several chances to accomplish what others easily and regularly do, if such a man not only does not reach standard time but cannot get out the work in twice standard time, he ought not wait to be discharged, but have enough decency to take his time and then take up some other occupation more suited to his temperament.

Does the individual effort system result in discharging old men because they cannot attain the times of younger and stronger men? This question provokes a smile. The 20 per cent. extra pay is given, not for hard work, but for head work. The younger men may not know it, but the older men are wiser, and if they do not have the bull-strength method of accomplishing, they supplement energy with intelligence in running a machine or planning an operation. They make few false moves, they take the stitch in time, they know that a carefully tempered and ground tool set at exactly the right angle will cut easier, faster and longer than a tool selected and set without the knowledge that long experience alone gives. Young men by driving their machines at an extraordinary rate have earned extraordinary pay, but it is the older men who in the long run will draw the most extra pay, who turn out the most reliable and satisfactory results. Some of the most productive workers are men between 50 and 60: productive not because they use their muscles, but because they use their heads.

In certain shops where this system is in operation, the most valued workers are men who have been with the company in these same shops for fifteen to twenty years, and under the individual effort system they are earning higher pay than they ever earned before, even in their so-called prime, and there is no reason why a good man should not earn day wages and individual effort reward until he is 70 years old or more. No portion of the gain made by workers is given to any foreman, nor a cent of it to any betterment-force employe. Foremen are paid by the day or month, and whatever extra they earn is based on the assembling of work on time and on efficient support given the workers.

The individual effort method of increasing the reward of the wage-earner includes all that is best in other methods, and attempts to exclude all that is objectionable. Its good points are summed up as follows:

1. The standard time set is reasonable and one that can be reached without extraordinary effort, is in fact such time as a good foreman would demand.

2. An extra reward of one-fifth of the regular wages for the operation is given to whoever makes standard time.

3. Extra compensation above the hourly rate is paid even if standard time is not reached, although this extra compensation diminishes in percentage above standard time-and-a-half.

4. If longer than time-and-a-half is taken, the regular day rate is paid. Of this, the wage-earner is also sure.

5. Standard time is carefully determined by observation and experiment, and is only changed when conditions change.

7. The arrangement is one of mutual benefit to both parties—of increased earning to the worker, of increased saving to the employer.

8. The employer loses more than the wage-earner if schedules do not encourage co-operation.

9. The wage-earner, working on a schedule, becomes in a large degree his own foreman.

10. The wage-earner determines his own earning power, and by co-operating to cut out wastes increases his own value.

The direct results of shop betterment and individual effort are:

FOR THE EMPLOYE.

To shorten the hours of labor.
To enable each man to determine his own earning capacity.
To increase earnings.
To do away with overtime.
To make him self-reliant.
To add to his value as he grows older.
To add to his comfort and safety in the shop.
To harmonize relations with the employer.

FOR THE EMPLOYER.

To decrease the cost of production.
To lessen the delays on each job.
To lessen careless wastes and breakages.
To increase the output for the same investment of capital.
To secure a higher class of employes.
To harmonize relations with employes.

This individual effort reward method of adding to the gains of both employer and employe has been recently adopted in the shops of one large railroad company, but is not yet in use by any other railroad or private concern. It is essentially a method of co-operation and profit-sharing. However much the employer may better conditions, he cannot materially reduce expenses unless the wage-earner co-operates; and however hard the wage-earner may work, he cannot increase his pay unless the employer provides the right conditions. In justice to both parties, all schedules and changes should be matters of written, not verbal, record, and while schedules can be put provisionally into effect, it should be understood that approval is not authoritative until signed by the high official who has jurisdiction over such matters. All concerned, whether workers, foremen, timekeepers, or record clerks, can, by inquiry, find out all about the conditions. It is the worker's business to know what schedule he is working under, and that its heading tallies with the work he is doing. Occasional disagreements between employer and employe seem natural, but not a conflict, since both look to the same shop and the same operations for their living, and also because there should be no conflict about creating value out of what is usually destroyed, about eliminating gross wastes which profit neither employe nor employer. The saving is so large as to afford both employe and employer gain far above the average, in which each, with *fairness*, unspoiled by *favoritism* or *subserviency*, and without *drudgery*, can share in proportion to individual efficiency.

STATUE OF MATHIAS BALDWIN.—A statue of Mathias Baldwin, founder of the Baldwin Locomotive Works, has been presented to the city of Philadelphia by officials of the firm, and will be unveiled in the spring. It cost \$18,000, and will be placed in Fairmount Park. An inscription on the statue reads: "His skill in the mechanic arts, his faithful discharge of the duties of citizenship, his broad philanthropy, unfailing benevolence and devotion to all Christian work, placed him foremost among the makers of Philadelphia."

The report of the Board of Railroad Commissioners of the State of New York shows that for the year ending June 30, 1905, but two passengers out of 97,060,279 were killed from causes beyond their own control; 12 were killed by their own misconduct or incaution, and 1 because of intoxication.

SIMPLE 10-WHEEL LOCOMOTIVE WITH YOUNG VALVE GEAR.

DELAWARE & HUDSON COMPANY.

The Delaware & Hudson Company recently turned out from its Green Island shops four ten-wheel culm burning locomotives, built after designs worked up in the motive power department.

These locomotives, one of which is illustrated herewith, have 21 by 26-in. cylinders and 63-in. drivers. They weigh about 173,000 lbs. total, of which about 75 per cent. is on

10-WHEEL LOCOMOTIVE WITH YOUNG VALVE AND GEAR—DELAWARE & HUDSON COMPANY.

drivers. The boiler is constructed for burning culm, and has a firebox about 10 ft. long by 8 ft. 6 ins. wide, giving a grate area of nearly 85 sq. ft. The grate is supported on water bars. The fireman's cab has been given special attention, and is all part of the locomotive; the hood on the tender usual for this type of engine being omitted, and the roof of the cab having a long extension to take its place.

The table of dimensions, weights, etc., below will show the features of these locomotives, which are, in general, the design which experience has shown to be satisfactory for this class of service.

The Young valve gear, used on two of these engines, is an adaptation of the Corliss principle for locomotive use. It employs the rotating valves operated from a wrist plate, which is oscillated by a connection from the rocker arm. Back of the rocker arm the ordinary Stephenson link valve gear is used without change. The principal feature in which this gear differs from the Corliss is that one valve is used for both admission and exhaust control, and that the wrist plate pivot is movable. This pivot is fastened to the end of one arm of the bell crank, the other arm of which has a direct connection to a short crank arm on the reverse shaft. The fulcrum of this bell crank is rigidly fastened to the cylinder casting.

The special features concerning steam economy which this valve introduces are that a constant steam lead is maintained at all points of cutoff, and the exhaust lead is increased as the cutoff is shortened. The valve gives a very quick cutoff, preventing wire drawing at this point, and in the same manner opens readily, giving a full port opening for the admission. The increasing exhaust lead gives an earlier exhaust opening and a delayed exhaust closure when the locomotive is working at high speed on a short cutoff. All of these comparisons are made with the ordinary slide valve. The design of the gear permits, by arranging for two passages, of a larger port opening than would be possible with either a slide or piston valve. The area of the steam ports in this locomotive are 32 sq. ins., as compared with 24¾ for a slide valve engine of the same type.

The illustrations given herewith show the mechanical features in a clear manner. It will be seen that the valve chambers and all passages connecting therefrom are included in the cylinder casting, there being two valves for each cylinder, each set directly above the port entering the cylinder, being 11½ ins. in diameter 22½ ins. long inside the bushing, and having their axes at right angles to that of the cylinder. It will be noticed that there is a supplementary passage extending from the top of the valve chamber, around the outside and joining the one going from the bottom of the chamber directly to the cylinder. This allows the steam to have two passages, and with the same distance of port opening gives a length equal to twice the length of the valve strip; exhaust steam also follows the same path. It will also be noticed that the passage of the steam to and from the cylinder is more direct than that usually found in the slide or piston valve. The back head of the valve chamber is cast integral with the cyl-

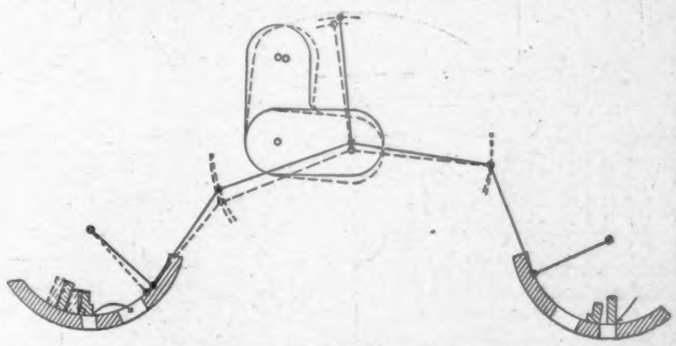


DIAGRAM SHOWING THE EFFECT OF MOVING WRIST PLATE FULCRUM ON EXHAUST LEAD—YOUNG VALVE GEAR.

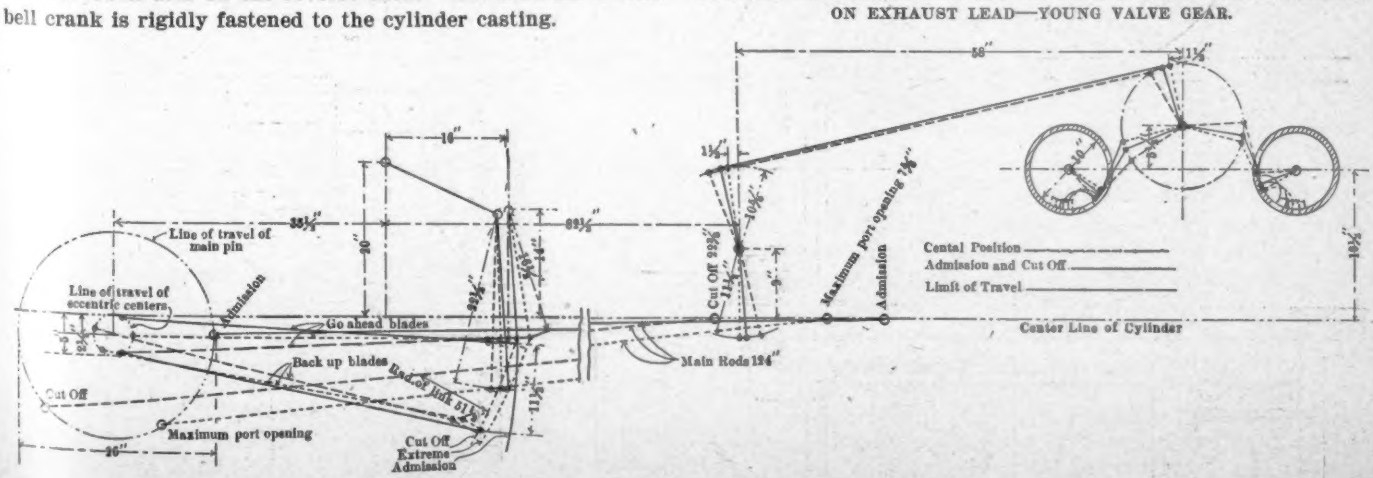
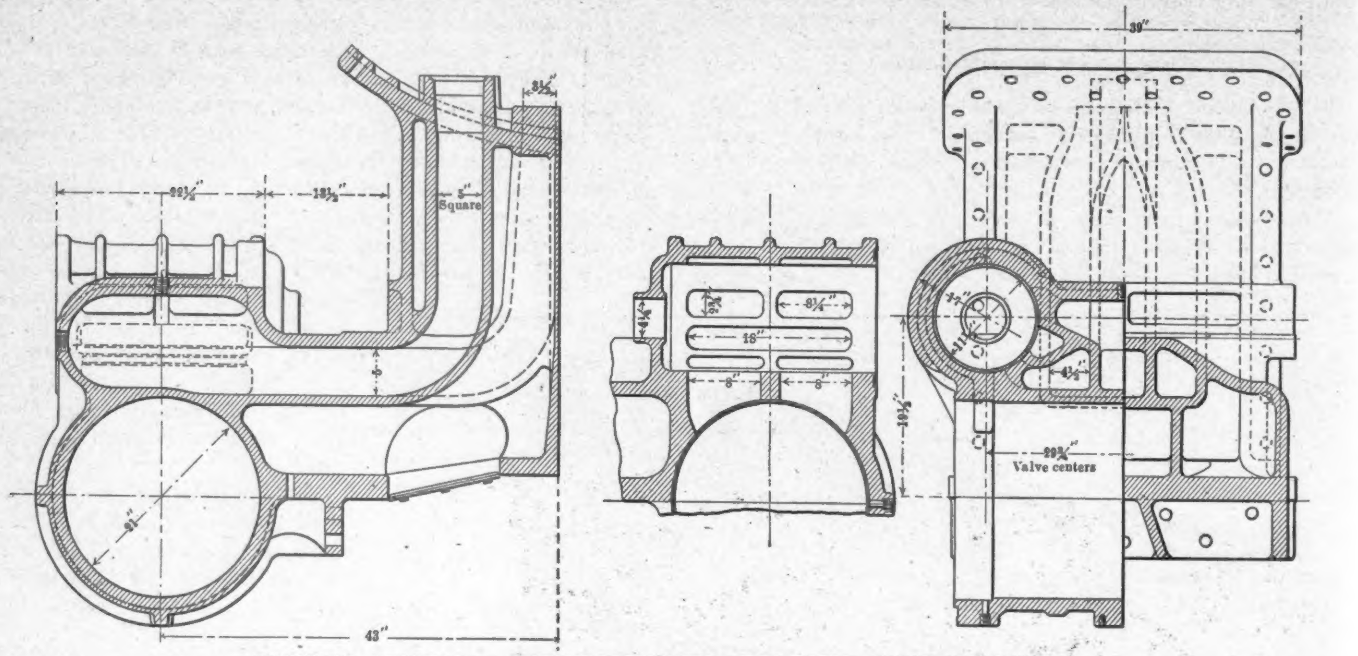


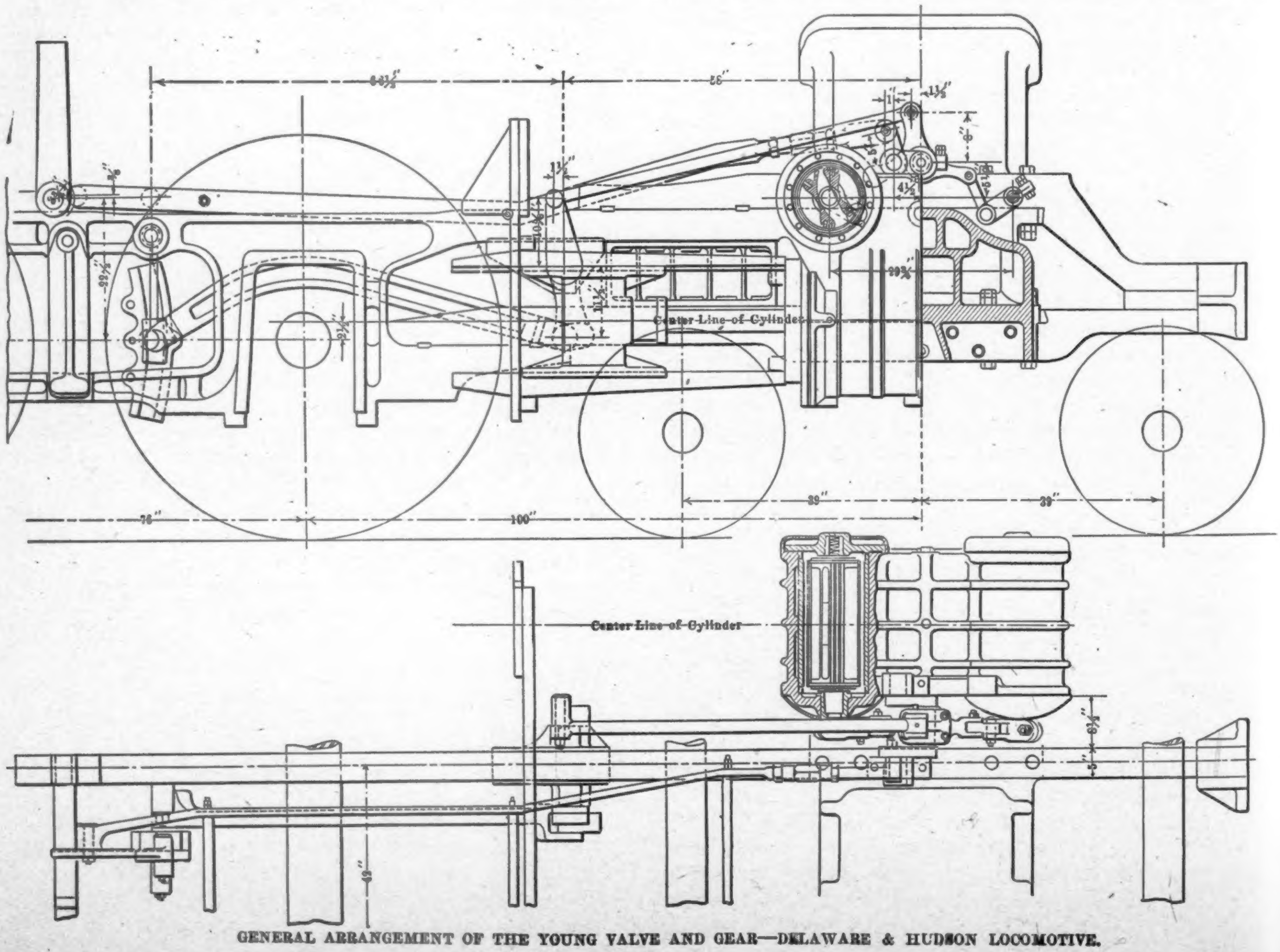
DIAGRAM SHOWING OPERATION OF THE YOUNG VALVE GEAR.



CYLINDERS—DELAWARE & HUDSON LOCOMOTIVE WITH YOUNG VALVE AND GEAR.

inder casting, and only has an opening for the valve shaft, the front head, however, is removable.

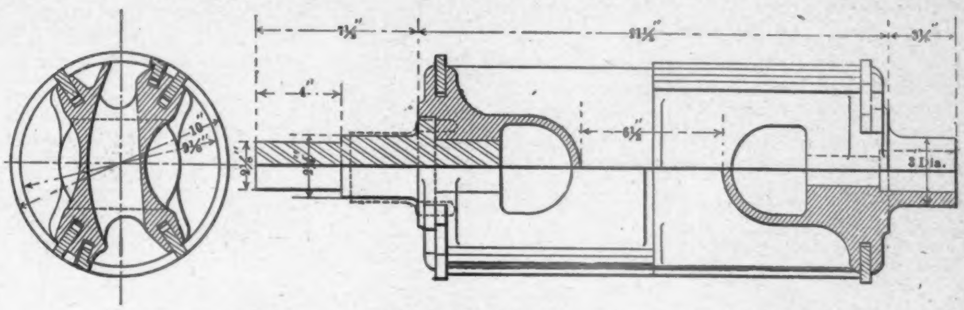
The construction of the valve itself shows plainly in the sectional views. It is constructed of cast iron, of a light section and of peculiar shape; the packing strips, of which there are two on the controlling side, and one narrow one in the wall separating live from exhaust steam, are of the same design used in the Richardson balanced valve, having light flat springs to hold them against the chamber wall. There are also packing strips extending around the ends between the longitudinal strips for preventing leakage at this point. These are separate pieces and abut the ends of the other strips. The stem, which is of steel, is fitted into one end of the valve and fastened with four dowels. This stem extends through the inner chamber head and carries the arm through which the valve is operated. The method of making a steam-tight joint at this point is interesting and effective. There is a brass bushing fitted into the casting and turned to a taper of ½ in. in 12 ins. on the inside for a distance of 2¼ ins. A ¼-in. lip is formed on the outer end, against which the shoulder of the valve stem, which is turned to make an exact fit in this bushing, rests. The valve stem also rests against the inner face of the bushing where there are a number of grooves cut to allow a small amount of steam to pass around the stem and



GENERAL ARRANGEMENT OF THE YOUNG VALVE AND GEAR—DELAWARE & HUDSON LOCOMOTIVE.

lubricate the bearing. On the opposite end of the valve the bearing is made in the head and steam pressure between the head and valve holds the valve up against the shoulder of the inner bearing. A coil spring holds it in place when steam is shut off. This method, which employs no packing of any kind and needs no attention as to lubrication, has proved to be very satisfactory. The coil spring rests against a steel button, which prevents the spring affecting the rotary action of the valve.

The arms on the valve stem are securely keyed, but in such a manner that they are easily removed when it is desired to remove the valve from the chamber. These arms connect to the wrist plate through short links. The wrist plate, as above mentioned, has a movable fulcrum operated from the reverse shaft. All of this construction is heavy and rigid. The connection from the bell crank to the reverse shaft is direct and, in this case, is by two rods fastened to the reverse shaft arms a short distance from the shaft and cross braced for stiffness. This connection has a nut for adjusting its length. Connection from the rocker arm to the wrist plate is through a rod, very similar to the ordinary valve rod, which is not adjustable. Reference to the outline diagrams showing the movement of the valves will make its operation clear. The one showing the movement caused by the moving of the bell crank illustrates how, by moving the fulcrum of the wrist plate, the events connected with the admission of steam are undisturbed, while those connected with the exhaust are varied.



VALVE—DELAWARE AND HUDSON LOCOMOTIVE WITH YOUNG VALVE AND GEAR.

This type of valve gear was first placed upon two locomotives on the Chicago & Northwestern, one of which, a large, high-speed Atlantic-type locomotive, went into service with this valve gear on September 26, 1903, and was operated in the pool with other engines of the same type having piston valves. In that service, this engine showed itself to be capable of more reliable service and was able to handle heavier trains on the same schedule than were the other engines. The matter of diminished tire wear was especially noticeable, and the wear on all the valve parts was also very small. The engine was taken into the shop on April 25, 1905, after having run 122,000 miles, and it was found that the greatest wear on the valve gear was in the wrist-plate bearing, which is so constructed that it can be closed up as wear develops, and at that point it was but 1-32 of an inch loose. The eccentrics were but 1-64 of an inch out of round with but one exception, which was 1-32 of an inch out. The wear on the valve bushings and packing strips was negligible. This locomotive was again put into service after repairs, and at the present time is performing satisfactory work.

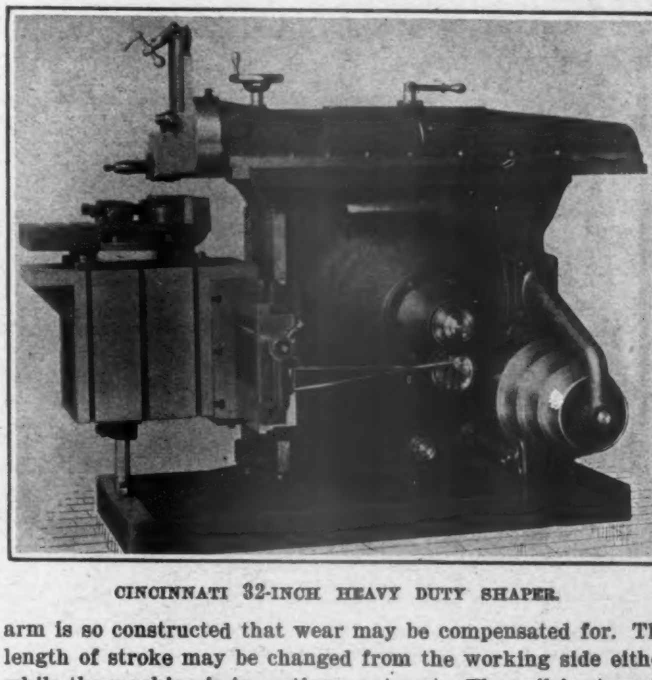
Of the two Delaware & Hudson locomotives, one has been in service at the present writing for over two months and the other for about thirty days. Both are reported to be giving excellent satisfaction in both fast and slow service. Three other railroad companies are at the present time about to place locomotives in operation equipped with this gear. The general dimensions of the D. & H. locomotive follow:

SIMPLE TEN-WHEEL LOCOMOTIVE—DELAWARE & HUDSON CO.

GENERAL DATA.	
Gauge	4 ft. 8½ ins.
Fuel	Culm.
Tractive power	31,000 lbs.
Weight in working order	173,000 lbs.
Weight on drivers	130,000 lbs.
Weight on leading truck	43,000 lbs.
Weight of engine and tender in working order	298,000 lbs.
Wheel base, driving	15 ft.
Wheel base, total	26 ft. 4 ins.
Wheel base, engine and tender	53 ft. 7½ ins.
RATIOS.	
Tractive weight ÷ tractive effort	4.2
Tractive effort x diam. drivers ÷ heating surface	730
Heating surface ÷ grate area	31.5
Tube heating surface ÷ total heating surface	.904
Tube heating surface ÷ firebox heating surface	13.4
Total heating surface ÷ vol. both cylinders	256.
Grate area ÷ vol. both cylinders	8.17
CYLINDERS.	
Kind	Simple.
Diameter and stroke	21 by 26 ins.
Piston rod, diameter	3½ ins.
Vol. both cylinders, cu. ft.	10.4
VALVES.	
Kind	Rotary.
Greatest travel	3⅝ ins.
Outside lap	¾ in.
Inside lap	⅛ in.
Lead in full gear	⅛ in.
WHEELS.	
Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, diameter and length	9 by 13 ins.
BOILER.	
Style	Wooten.
Working pressure	200 lbs.
Outside diameter of first ring	65 ins.
Firebox, length and width	120 by 102 ins.
Tubes, number and outside diameter	308 2-in.
Tubes, length	15 ft.
Heating surface, tubes	2,405.5 cu. ft.
Heating surface, water bars	78.54 cu. ft.
Heating surface, firebox	179.68 cu. ft.
Heating surface, total	2,663.72 cu. ft.
Grate area	84.85 sq. ft.
Smokestack, height above rail	14 ft. 9 ins.
Center of boiler above rail	111½ ins.
TENDER.	
Tank	Water bottom.
Weight, empty	48,000 lbs.
Water capacity	7,000 gals.
Coal capacity	12 tons.

32-INCH HEAVY DUTY SHAPER.

The 32-in. heavy duty shaper, illustrated herewith, is specially designed for use in railroad shops, is very powerful, and the construction is such that work may be turned out very accurately under the most severe conditions of cutting. The column, which is of unusual width and depth, is braced internally. The horns, which project at both the front and back, furnish an unusually long bearing for the ram. The rocker arm is so constructed that wear may be compensated for. The length of stroke may be changed from the working side either while the machine is in motion or at rest. The rail is strongly gibbed to the column, and a cross traverse screw is provided with a graduated collar reading to .001 in. It is also provided with a variable automatic feed which may be changed while the machine is in operation. The down-feed screw to the head has a graduated collar reading to .001 of an inch.



CINCINNATI 32-INCH HEAVY DUTY SHAPER.

The journal of the main gear has two diameters, the inner end being twice the diameter of the outer end, thus overcoming any tendency to break at the gear; there is also a third or

outer bearing to the cone shaft. The crank block is a steel casting and is set well into the cup of the gear, permitting the rocker arm to travel close to the edge of the gear, thus avoiding the usual overhang.

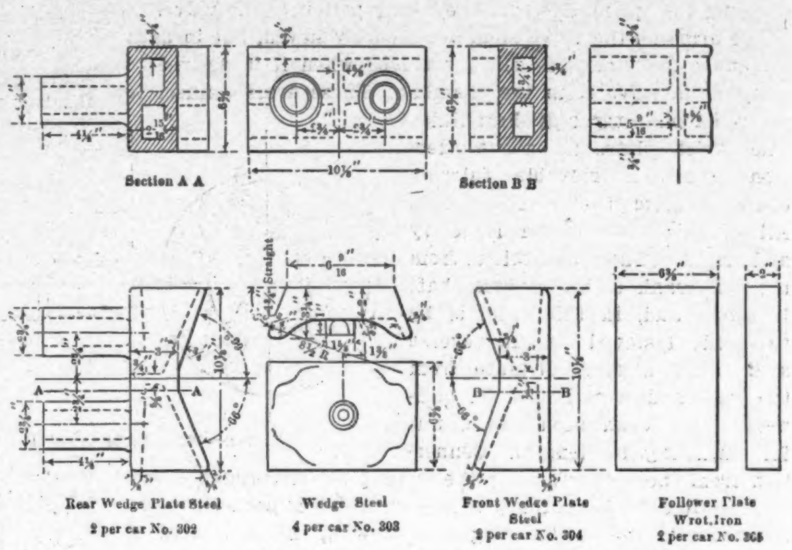
The machine may be used in either single or back-geared form, the ratio of the gearing in one case is 7.2 revolutions of the cone shaft to one stroke of the ram and in the other 30 to 1. The cross feed connecting rod is automatically adjusted to any height of the rail, and is not dependent upon frictional contact. The outer support for the table is of special design and very efficient. The rail is raised and lowered by a telescopic screw, which works on ball bearings. The key-seating of shafting is provided for by an opening through the column under the ram.

The general dimensions of this machine, which is made by the Cincinnati Shaper Company, Cincinnati, Ohio, are as follows:

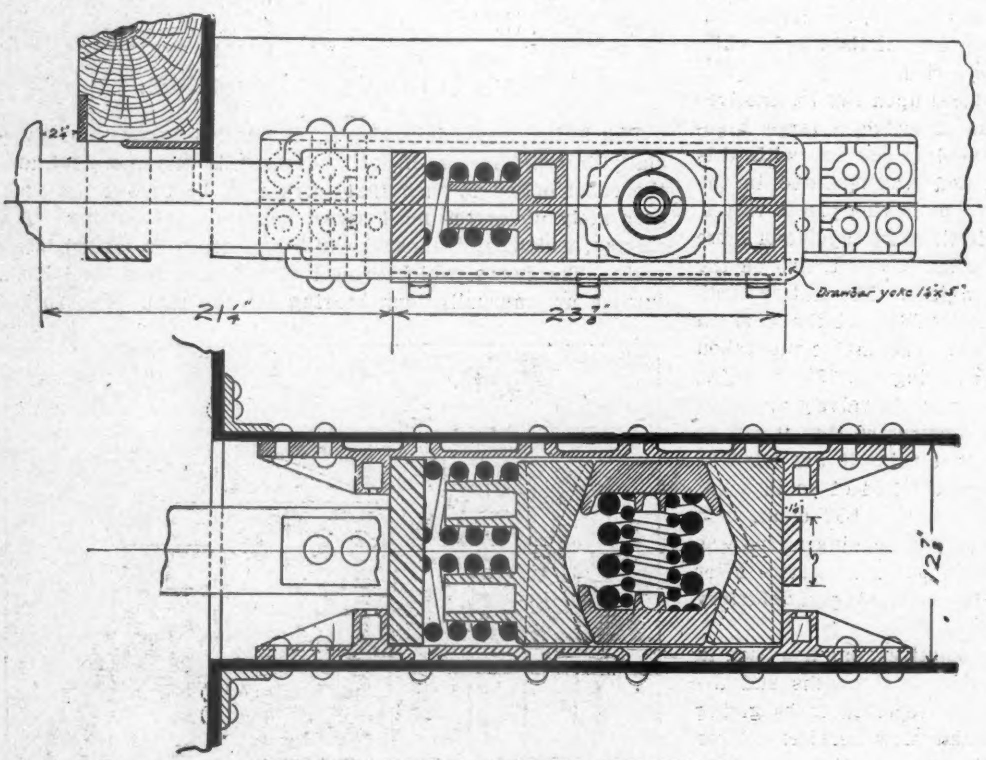
Extreme length of stroke	33 ins.
Greatest distance table to ram	17¼ ins.
Least distance table to ram	2¼ ins.
Vertical travel of table	15 ins.
Horizontal travel of table	32 ins.
Diameter of head	11 ins.
Feed to head	10 ins.
Length of top of table	30 ins.
Width of top of table	16 ins.
Depth of table	20 ins.
Length of ram bearing in column	46 ins.
Width of ram bearing in column	13 ins.
Key-seating capacity, diameter	4 ins.
Vise opens	12 ins.
Number of speeds to ram	8
Cutting strokes per minute, from	6 to 71

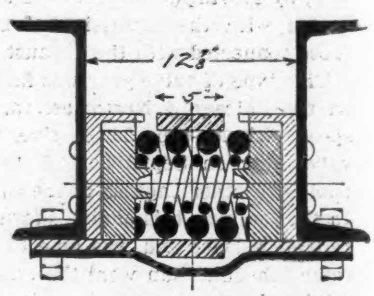
PIPER FRICTION DRAFT RIGGING.

The Piper friction draft rigging, which has been brought to a high point of efficiency through several years of tests and experiments on a large number of cars in actual service, has not until now been placed on the market. The patent granted



DETAILS OF WEDGE PLATES, WEDGES AND FOLLOWER PLATE.

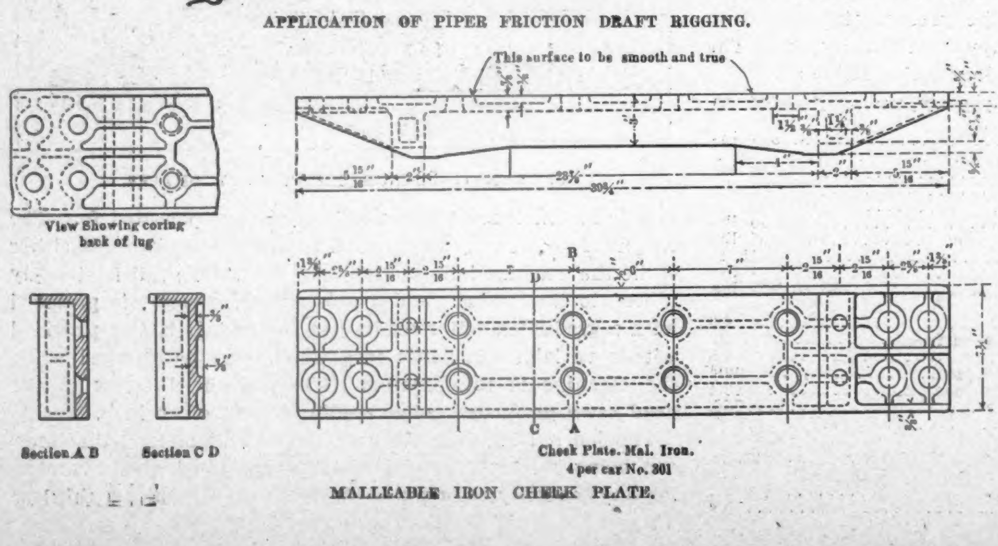




APPLICATION OF PIPER FRICTION DRAFT RIGGING.

to W. M. Piper in 1896 is a pioneer patent and covers broadly any mechanism consisting of blocks having oppositely directed inclines with contracting wedges and springs arranged to resist their movement along the inclines. The arrangement, as illustrated, is one that was developed after exhaustive tests in service and in the laboratory, both as to the amount of preliminary spring resistance necessary, as well as the best angle for the wedges to give an easy movement and a high point of work-absorbing efficiency. The diagram of a test made at Purdue University in 1903, and reproduced here, shows that this particular arrangement is capable, with a preliminary spring movement of 1¼ in. and 25,000 lbs. resistance, of a very high yielding resistance through a total drawbar movement of 2¼ in.

It is generally understood that the first requisite of a good friction draft gear is that it should not be liable to disorder or repair; that the parts be simple and substantial in design, easily

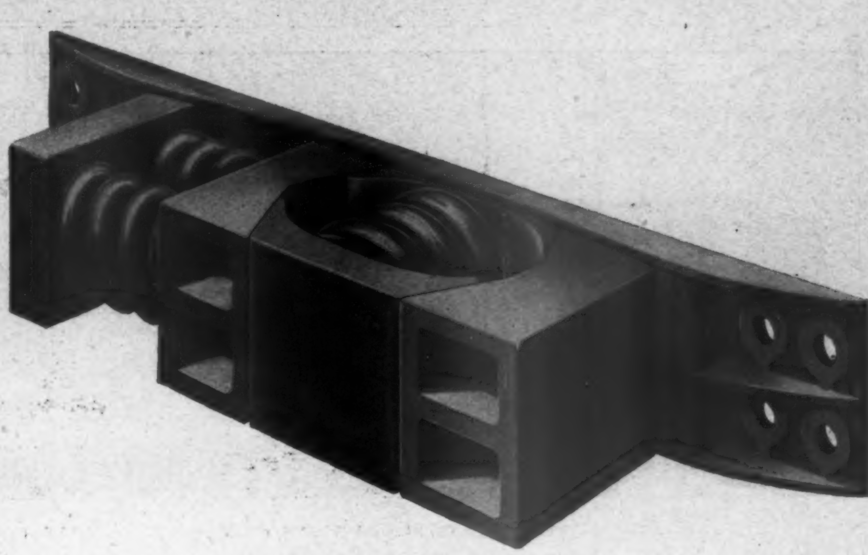


MALLEABLE IRON CHEEK PLATE.

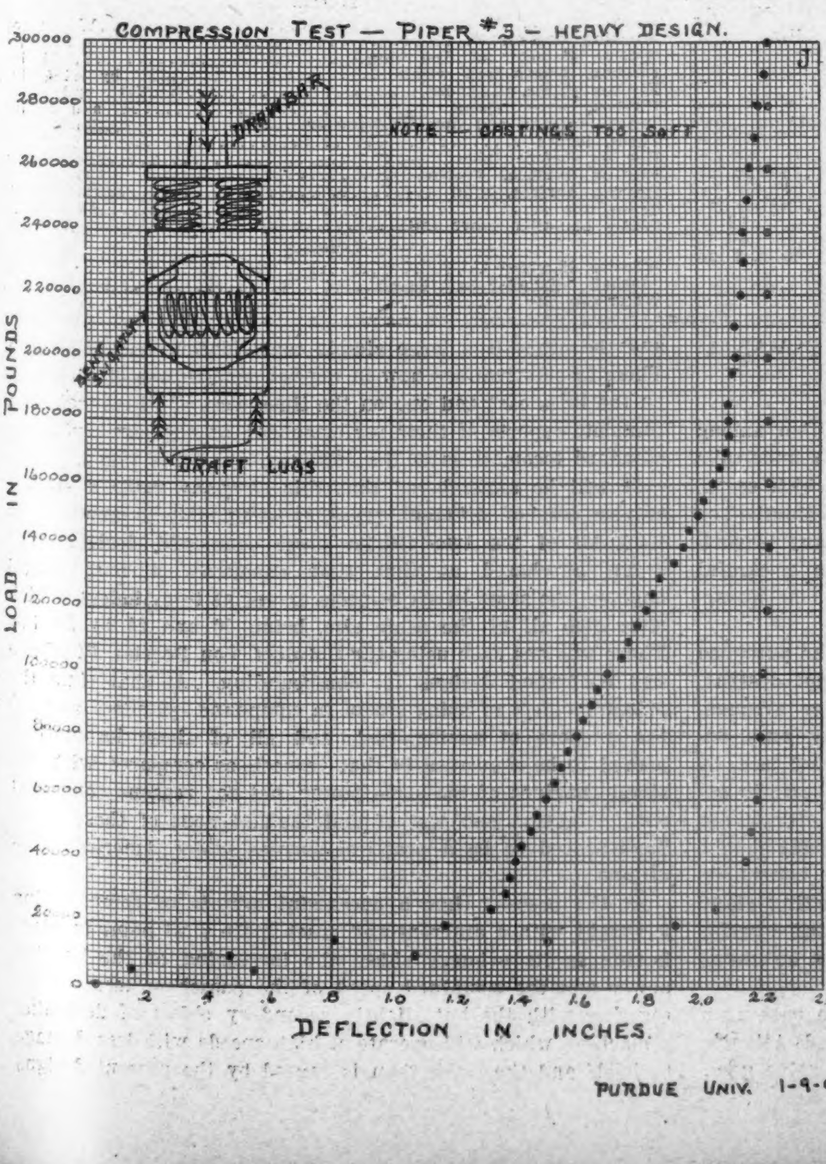
inspected, incapable of being improperly assembled and of such form and construction that it may be cheaply and firmly fastened to the frame of the car, all of which has been thoroughly considered and effectively accomplished in the design of the Piper friction draft rigging.

The road tests of this draft rigging demonstrated the fact that a very considerable amount of easy motion was desirable in the starting of trains and in absorbing the innumerable slight shocks incident to train service. This element is thoroughly taken care of by the front twin-spring arrangement, the friction elements going into operation gradually, with a smooth, easy motion, before the springs are completely compressed, and no shock is possible. An absorbing element, capable of a resistance of 180,000 to 200,000 pounds for each end of a car should give very satisfactory results under the most severe service conditions.

The patents covering the Piper friction draft gear are now owned and controlled by the Butler Drawbar Attachment Company of Cleveland, Ohio, and the gear will be known as the Butler Friction Attachment—Piper Patents. This form of draft gear is capable of being applied in various ways, and any special requirements can be met, the limitations of space and travel being considered, and while being new on the market, it has the superior advantage of having been thoroughly tested in severe service for several years. The high capacity and guaranteed efficiency of the Butler Friction Attachment must certainly recommend it to the operating officials of any railroad.



PIPER FRICTION DRAFT GEAR ASSEMBLED.



BALANCED COMPOUND TEN-WHEEL LOCOMOTIVE.

N., C. & ST. L. R. R.

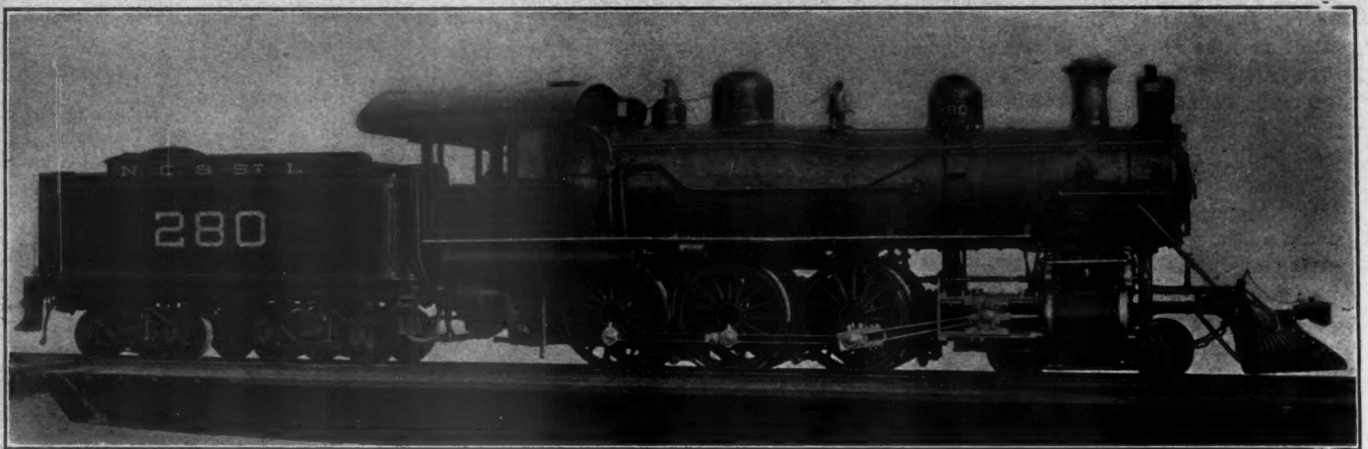
The twenty-seventh thousandth locomotive built at the Baldwin Locomotive Works was a balanced compound, 10-wheel engine for the Nashville, Chattanooga & St. Louis Railway, which is illustrated herewith.

This locomotive has 16 and 27 by 26 inch cylinders and has both main rods connected to the front driver. While this arrangement gives comparatively short main rods, it allows the three driving wheels to be placed very close together, giving a rigid wheel base of but 12 ft., the total wheel base being 26 ft. This will allow the engine to easily take sharp curves, but probably will not tend towards an easy-riding locomotive. In spite of the fact that the driving wheels are set far enough back to connect the rods to the front wheel, the design is such that 73 per cent. of the total weight comes on the drivers. Compared with engines using a trailing wheel, this is a large percentage.

The eccentrics are, of course, on the second axle, and the rocker arm is placed between the two front drivers and connects with the valve through a very long valve rod, which passes through the front driving box spring cap and has a bearing in the guide yoke.

The single bar front frame, necessary with this type of cylinder, is made particularly heavy in section and strong in connection. The connection to the main frame is secured by 8 1¼ in. bolts in addition to two large keys, and at the cylinders, where the frame has a section of 3½ by 8 ins., it is fitted into a recess in the cylinder casting and secured by lugs, on either end, with keys, also by two 1⅛ in. bolts, which pass through the frame and lugs on the castings as well as six straps across the bottom. This detail appears, in this case, to have received the thought and care that it really deserves.

A narrow firebox, having a grate area of but 34.8 sq. ft., and a wagon-top boiler, with a diameter of 64 ins. at the front end, is used. The heating surface is, however, larger than might be expected, as but 17-ft. flues are used, it being 2,735 sq. ft. total; this gives 78.5 sq. ft. of heating surface per sq. ft. of grate area, a figure which was not unusual when narrow firebox locomotives were general, but one which is considerably larger than is found in the later engines. The flues, which are 2¼ ins, in diam-



10-WHEEL (4-6-0 TYPE) BALANCED COMPOUND LOCOMOTIVE—NASHVILLE, CHATTANOOGA AND ST. LOUIS RAILROAD.

eter, are set at 3-in. centers. This permits 256 of them to be placed in the boiler shell. A steam pressure of 210 lbs. is used.

Reference to the table of proportions of this locomotive will show that, as compared with a simple engine of the same power, it would be considered that the cylinders were somewhat large for the boiler capacity, but, inasmuch, as the balanced compound feature is used and the cylinder power is divided more evenly, this will probably not prove to be the case the B D factor (tractive effort × dia. drivers ÷ total heating surface*) while somewhat above that employed in recent balanced compounds, still is not excessively large, and would indicate that the engine would do its best work at a medium sped.

The general dimensions, weights and ratios follow:

4—6—0 TYPE VAUCLAIN BALANCED COMPOUND PASSENGER LOCOMOTIVE, NASHVILLE, CHATTANOOGA AND ST. LOUIS RY.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Fuel	Bituminous coal.
Tractive power	29,050 lbs.
Weight in working order	181,380 lbs.
Weight on drivers	133,920 lbs.
Weight on leading truck	47,460 lbs.
Weight of engine and tender in working order	280,000 lbs.
Wheel base, driving	12 ft.
Wheel base, total	26 ft.
Wheel base, engine and tender	55 ft. 2 ins.

RATIOS.

Tractive weight ÷ tractive effort	4.6
Tractive effort x diam. drivers ÷ heating surface	702
Heating surface ÷ grate area	78.5
Total weight ÷ tractive effort	6.24
Tube H. S. ÷ total H. S.	.932
Tube H. S. ÷ firebox. H. S.	13.8
Total H. S. ÷ vol. both cylinders	308
Grate area ÷ vol. both cylinders	3.92

CYLINDERS.

Kind	Balanced compound.
Diameter and stroke	16 and 27 by 26 ins.
Vol. both cylinders, cu. ft.	8.9

VALVES.

Kind	Piston.

WHEELS.

Driving, diameter over tires	66 ins.
Driving, thickness of tires	3 ins.
Driving journals, main, diameter and length	10 by 10½ ins.
Driving journal, others	9 by 12 ins.
Engine truck wheels, diameter	30 ins.
Engine truck, Journals	5½ by 12 ins.

BOILER.

Style	Wagon top.
Working pressure	210 lbs.
Outside diameter of first ring	64 ins.
Firebox, length and width	120 by 41⅞ ins.
Firebox plates, thickness	⅜, 7-16 and ½ in.
Firebox, water space	4 and 3 ins.
Tubes, number and outside diameter	256 2¼-in.
Tubes, length	17 ft.
Heating surface, tubes	2,550 sq. ft.
Heating surface, firebox	185 sq. ft.
Heating surface, total	2,735 sq. ft.
Grate area	34.8 sq. ft.
Centre of boiler above rail	106 ins.

TENDER.

Wheels, diameter	33 ins.
Journals, diameter and length	5 by 9 ins.
Water capacity	5,000 gals.

*American Engineer, Feb., 1903, p. 58.

EXPERIMENTAL LOCOMOTIVES, PENNSYLVANIA RAILROAD.

The Pennsylvania Railroad holds a special position among American Railroads in respect to its readiness to undertake the careful testing of any new design or device which seems to have elements pertaining toward improved locomotive or car performances. The organization of the company is such that testing of this nature can be carried on in a careful and thorough manner and the results obtained can be accepted as accurate and reliable.

The latest evidence of this position is found in the purchase of eight new locomotives, two each of four different designs, each including some comparatively new feature or arrangement. In selecting the types, those chosen were ones designed and built by the locomotive builders, which are in regular service on other railroads and which, to a certain extent, have been tried out and developed. In fact, all untried features were avoided as far as possible. To this group should also be added the DeGlehn compound locomotive bought in 1904, and partially tested on the Pennsylvania testing plant at the St. Louis World's Fair. A complete illustrated description of that locomotive was given in the AMERICAN ENGINEER AND RAILROAD JOURNAL in June, 1904.

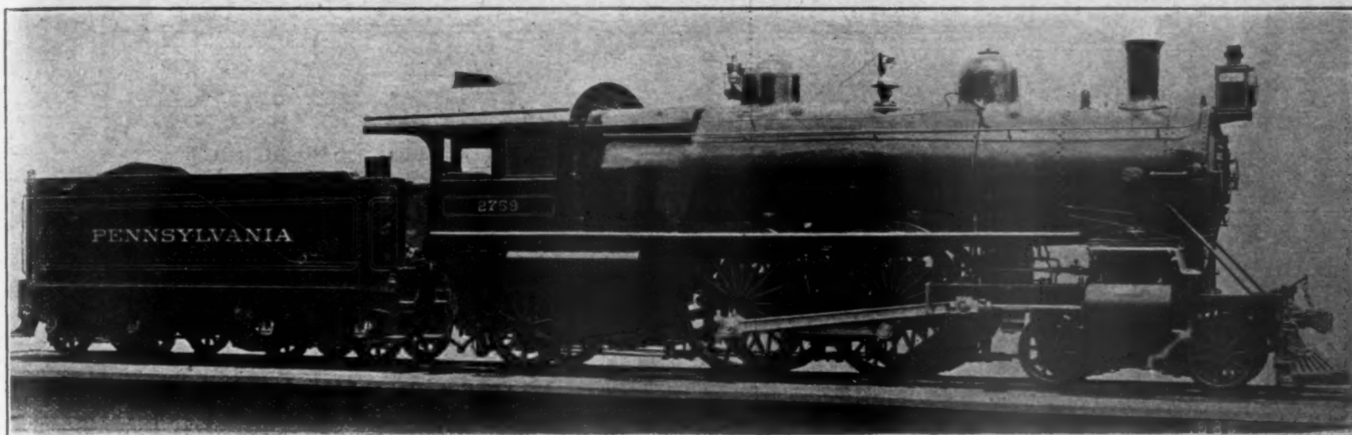
Of the four types of American design, three are passenger locomotives; two of which are balanced compound Atlantic type and one simple Prairie type with Walschaert valve gear, and the other is a large simple consolidation freight engine. These locomotives are now in regular service, one of each type on the lines east and one on the lines west of Pittsburgh, and complete reports of their performances, as compared with the standard locomotives of the company, are being taken.

It will be remembered that this company made a similar service test of different types of compound locomotives in 1896, all of the two-cylinder cross compound design. The group purchased at that time consisted of four mogul engines, the same in all respects except as to cylinders, which were also all of the same size, being 20 and 29 by 28 ins. There was one each using the Golsdorf, Von Borries, Pittsburg and Richmond designs for compounding. At that time the primary object of using steam in compound cylinders was for the purpose of saving fuel, and all of these locomotives proved to be a success in that respect, as compared with the simple engines of the same power, but for reasons connected with operation and cost of maintenance none of those types have proved to be a practical success under American conditions.

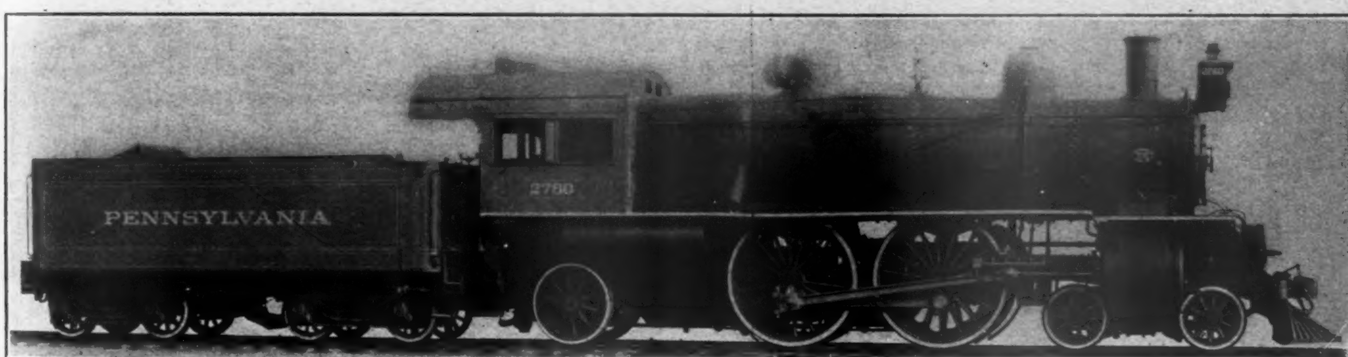
At the present time a successful system of compounding is sought with a different and much more vital point in view, having as its primary object the increasing of the hauling power and the sustained speed of the passenger locomotives, together with the but slightly secondary object of designing a machine which will operate at high speeds with less damage to itself and the track than is caused by the present designs

of high speed locomotives. The three different designs for these purposes, included in this group have, in one case from long foreign and in two cases from comparatively brief American experience, shown themselves to be very successful and the indications are that these types will not follow their predecessors into quick disuse.

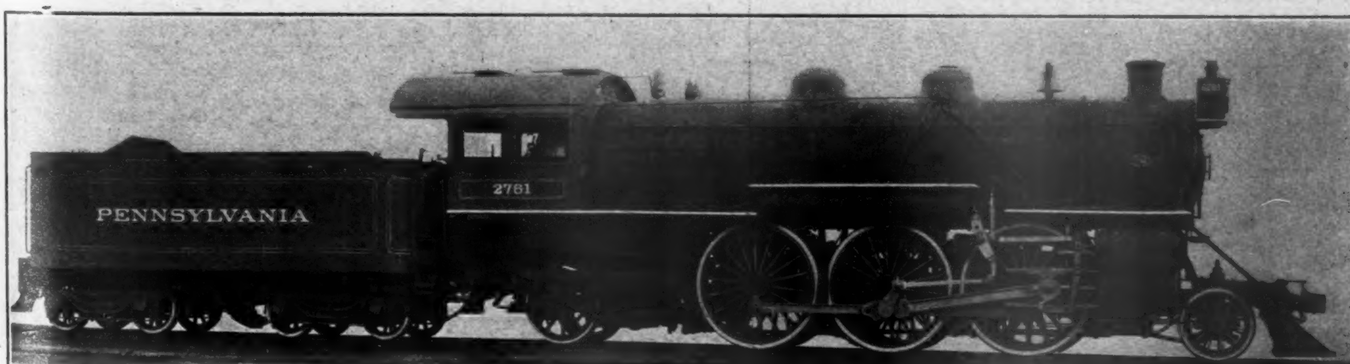
The other passenger locomotive is of a type which, while new on the Pennsylvania Railroad, has been in long service on other American roads, the most notable previous example being the class J-41 engine of the Lake Shore & Michigan Southern Railway (AMERICAN ENGINEER, 1904, page 413), which has, up to this time, held the record as being the heaviest passenger locomotive ever built. The test on this engine



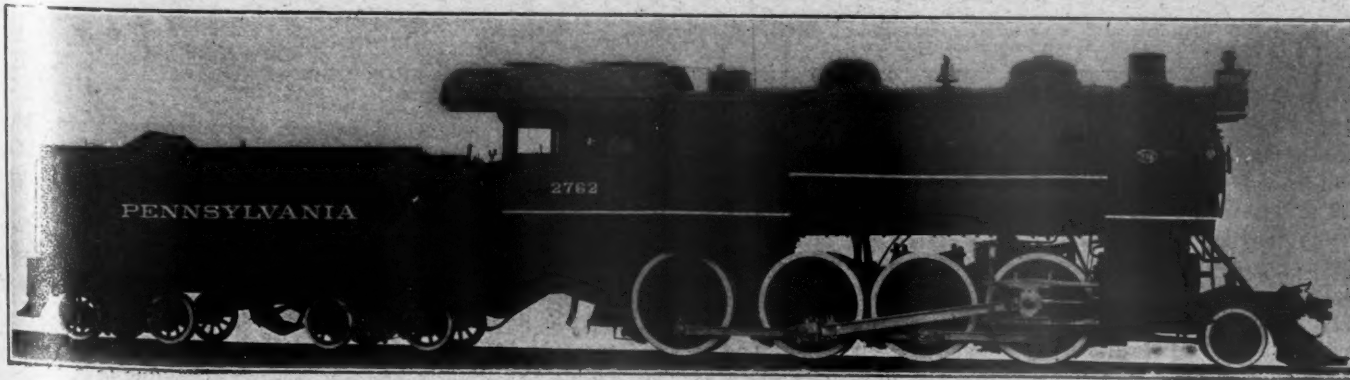
ATLANTIC (4-4-2) TYPE VAUCLAIN BALANCED COMPOUND LOCOMOTIVE—PENNSYLVANIA RAILROAD.



ATLANTIC (4-4-2) TYPE COLE BALANCED COMPOUND LOCOMOTIVE—PENNSYLVANIA RAILROAD.

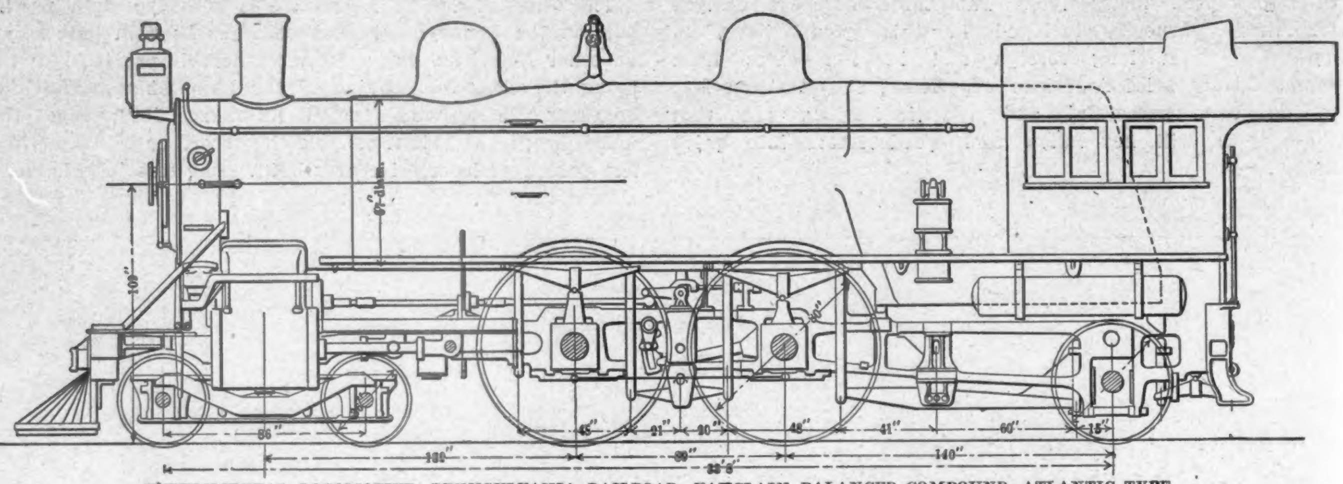


PRAIRIE (2-6-2) TYPE PASSENGER LOCOMOTIVE, WITH WALSCHAERT VALVE GEAR—PENNSYLVANIA RAILROAD.

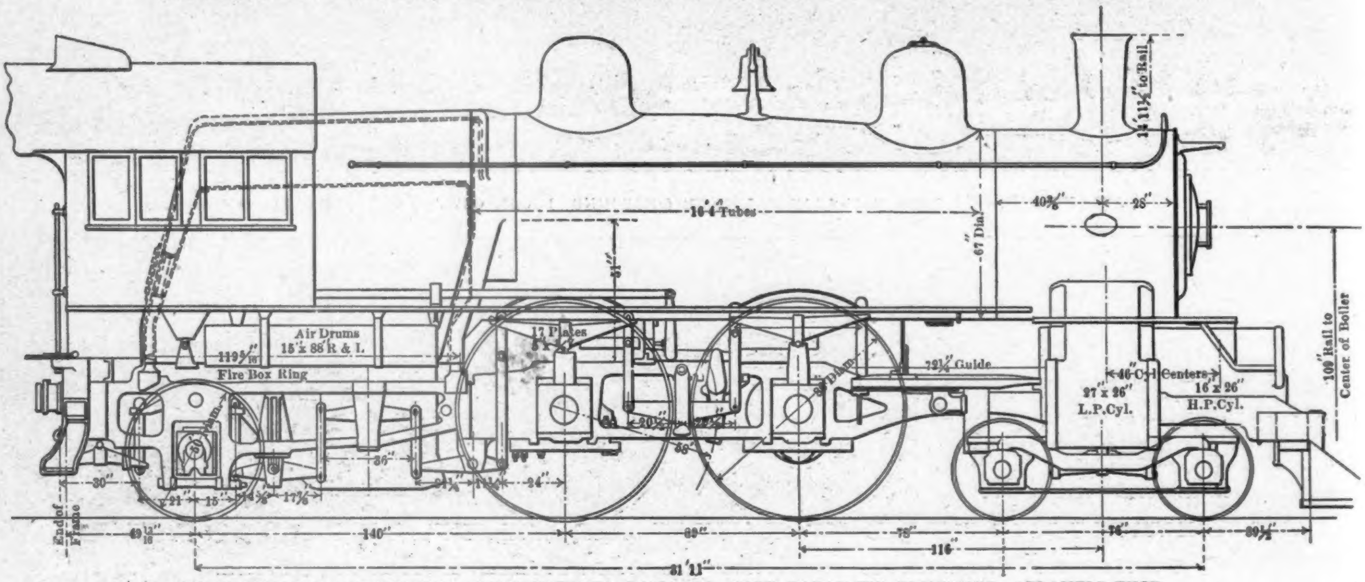


CONSOLIDATION (2-8-0 TYPE) FREIGHT LOCOMOTIVE—PENNSYLVANIA RAILROAD.

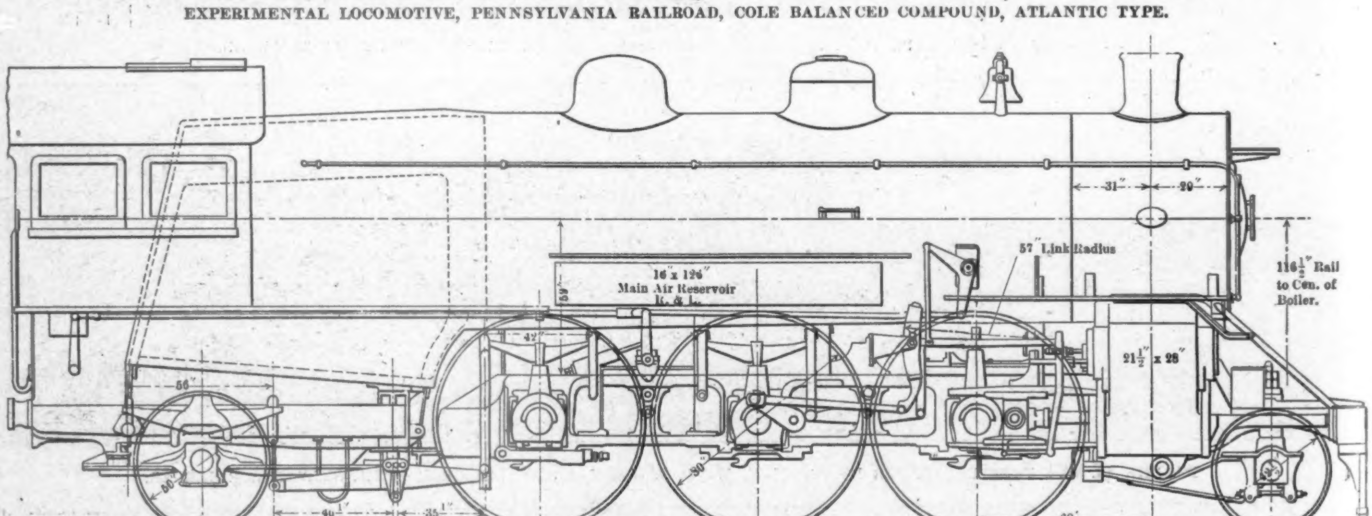
PENNSYLVANIA EXPERIMENTAL LOCOMOTIVES.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, VAUCLAIN BALANCED COMPOUND, ATLANTIC TYPE.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, COLE BALANCED COMPOUND, ATLANTIC TYPE.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, PRAIRIE TYPE, WITH WALSCHAERT VALVE GEAR.

will be two-fold—the use of the two wheel leading truck on a line having many curves and the performance of the Walschaert valve gear on a high speed passenger locomotive.

The fifth locomotive of the group, a large consolidation freight engine, is simply a very powerful engine for heavy service, built from a straightforward strictly American design.

Referring to the particular locomotives comprising this group, the table of dimensions, together with the general views and outline diagrams herewith, will give a clear idea of each.

The DeGlehn compound engine, as above mentioned, has been thoroughly illustrated and described in these columns, and while being included in this group for experimental purposes is not illustrated herewith.

The Prairie type passenger locomotive is almost identical with the Lake Shore & Michigan Southern Railway engine mentioned above, it being 1,500 lbs. heavier in total weight and having 800 lbs. more weight on drivers. The cylinders are the same in both cases, being 21½ by 28 ins. The former locomotive has slightly more heating surface, due to a larger number of tubes in the boiler. The diameter of the drivers

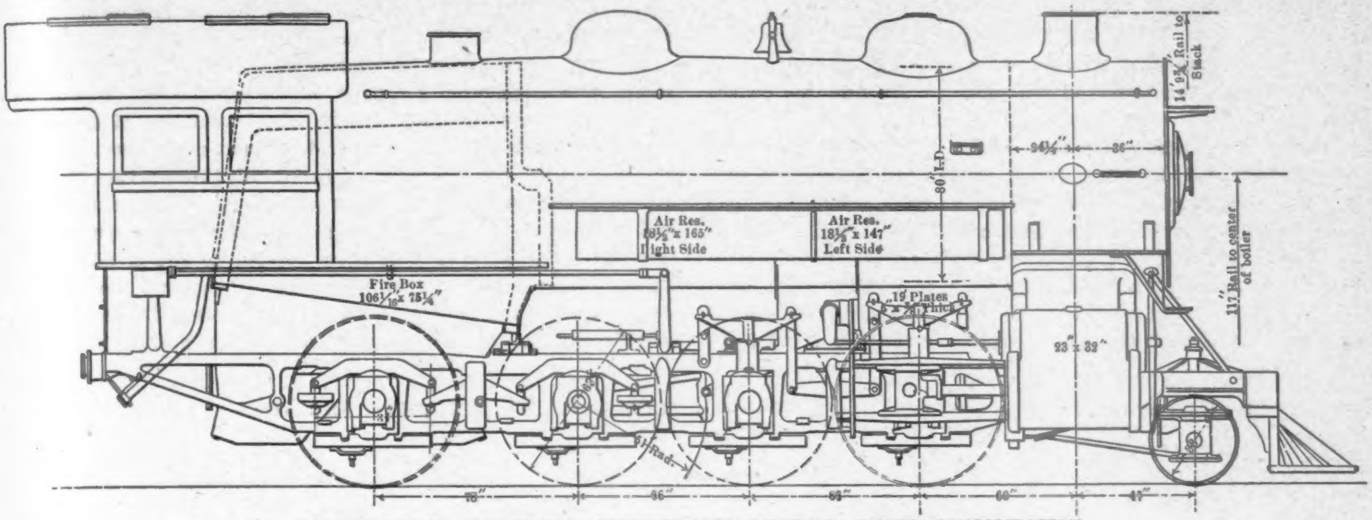
in the latter engine being one inch larger gives it a slightly less theoretical tractive power, but in all other respects, excepting the valve gear, the two locomotives are practically identical.

The Walschaert valve gear here used has been described and illustrated in principle and detail in these columns many times during the past two years. The reports from examples already in use seem to be uniformly favorable, and the present indications are that the gear will come into fairly general use in this country.

The two balanced compound Atlantic type engines will be seen, by referring to the tables of dimensions, to be practically identical in all respects except cylinder arrangements. They both employ 16 and 27 by 26 in. cylinders, weigh in the neighborhood of 200,000 lbs. total and carry 205 lbs. of steam. The boiler of the Baldwin balanced compound has slightly longer flues, there being 261—2¼ ins. in diameter and 17 ft. 8 ins. long, while the Cole compound of the American Locomotive Company has 315—2-in. flues 16 ft. 4 ins. long, the heating surface in both cases being almost the same.

For details of the cylinder arrangement and connection of the Cole balanced compound reference can be made to the illustrated description of a similar locomotive for the New York Central & Hudson River Railroad (American Engineer and Railroad Journal, June, 1904, page 241), and for the Baldwin balanced compound to a description of a similar locomotive for the Chicago, Burlington & Quincy Railroad in June, 1904, page 211, and for the cylinder arrangement to June, 1903, page 210.

The consolidation locomotive is almost an exact duplicate of a locomotive built by the American Locomotive Company for the New York Central & Hudson River Railroad, and illustrated in the American Engineer and Railroad Journal, January, 1904, page, 16. The Pennsylvania engine weighs 1,000 lbs. more in total and 2,000 lbs. more on drivers. The tractive power is the same in both cases.



EXPERIMENTAL LOCOMOTIVE, PENNSYLVANIA RAILROAD, SIMPLE CONSOLIDATION.

Dimensions, Weights and Ratios of Experimental Locomotives, P. R. R.

Type	2-6-2	4-4-2	4-4-2	4-4-2	2-8-0
Road Numbers	2761	2759	2760	2512	2762
Builder	American	Baldwin	American	Soc. Als.	American
Steam distribution	Simple	Bal. Comp.	Cole Comp.	De Glehn	Simple
Cylinder diameter, ins	21½	16 and 27	16 and 27	14.19 & 23.625	23
Stroke, ins	28	26	26	25.19	32
Total weight, lbs	234,500	195,900	200,500	164,000	220,000
Weight on drivers, lbs	166,800	120,500	117,200	87,850	198,000
Diameter of drivers, lbs	80	80	80	80.19	63
Valve	Piston	Piston	Piston	P & S	P
Valve gear (Walschaert or Stephenson)	W	S	S	W	S
Diameter of boiler	74½ ins.	67 ins.	67 ins.	58⅛ ins.	81⅝ ins.
Length of flues	19 ft. 6 ins.	17 ft. 8 ins.	16 ft. 4 ins.	14 ft. 5¼ ins.	15 ft. 6 ins.
Diameter of flues	2¼ ins.	2¼ ins.	2 ins.	2¾ ins. †	2 ins.
Number of flues	322	261	315	139	446
Length of firebox	108 1-8 ins.	111 in.	111 ins.	120 ins.	106 ins.
Width of firebox	73¼ ins.	72 ins.	72 ins.	39⅝ ins.	75¼ ins.
Grate area, sq. ft	55	55.5	55.5	33.9	55.4
Heating surface—flues, sq. ft	3677.9	2698	2,680	2435.7	3596.5
Heating surface—firebox, sq. ft	202.7	166	181.4	181.1	177.1
Heating surface—total, sq. ft	3881.6	2864	2861.6	2616.8	3773.6
Height, centre boiler	9 ft. 8½ ins.	9 ft. 1 in.	9 ft. 1 in.	8 ft. 10 5-16 in.	9 ft. 9 ins.
Steam pressure	200	205	205	227½	200
Tender—water capacity	7000 gals.	5500 gals.	5500 gals.	5500 gals.	7000 gals.
Tender—coal capacity	10 tons.	12½ tons	10 tons.	11 tons.	13 tons
Tender—weight loaded	139,300 lbs.	132,100 lbs.	125,300 lbs.	132,500 lbs.	140,500 lbs.
Vol. both cyl., cu. ft.*	11.76	8.9	8.9	7.15	15.4
Tractive effort	27,520	23,300	23,300	19,555	45,700
Ratio—Weight on drivers ÷ tractive effort	6.1	5.17	5.	4.5	4.33
" Total weight ÷ weight on drivers	1.41	1.63	1.71	1.87	1.11
" Total H. S. ÷ grate area	70.6	51.7	51.6	77.1	67.4
" Tube H. S. ÷ total H. S.	.946	.94	.937	.932	.954
" Tube H. S. ÷ firebox H. S.	18.12	16.3	14.8	13.42	20.25
" Total H. S. ÷ Vol. both cyl.	330	322	322	366	245
" Grate area ÷ Vol. both cyl.	4.68	6.23	6.23	4.74	3.6
" Tractive effort x diameter drivers ÷ total heating surface.	568	650	650	600	765

*Volume of cylinders of equivalent simple engine used for compounds.
† Serve tubes.

A RECORD IN TIRE TURNING.

Fifteen pairs of driving wheels, ranging from 50 to 72 ins. in diameter, turned in 13 hours 24 minutes, or requiring an average of 53 3-5 minutes to put a pair of wheels in the lathe, turn and take them out, is the record made at the West Albany shops of the New York Central. The chips removed from these wheels weighed 2,860 lbs. The results of the test are shown on the accompanying table. The tires in all cases were of Midvale steel. This record was made on December 18th and 19th, five pairs of driving wheels being turned out in 258 minutes on the 18th and ten pairs in 546 minutes on the 19th.

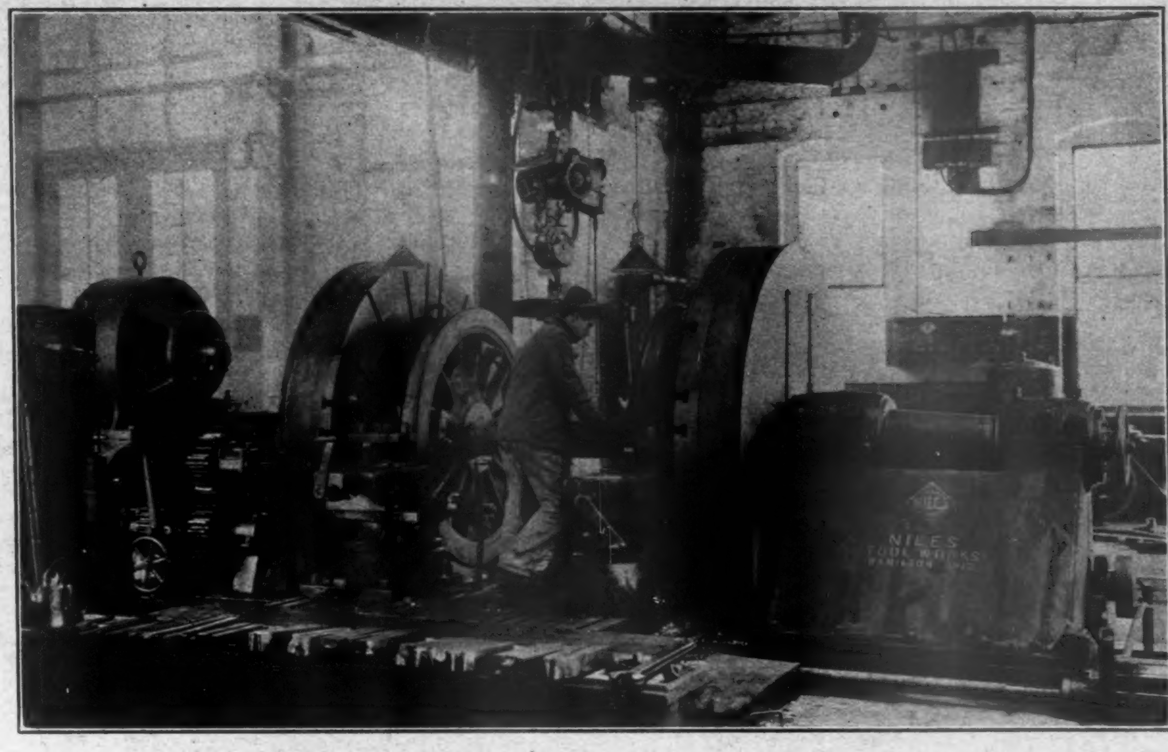
The machine upon which this record was made is the most recent design of 90-in. Niles driving wheel lathe equipped with the "sure grip" drivers, and weighs about 120,000 lbs. The face plates are provided with openings for the crank pins, so that the wheels may by chucked close to the face plates; the movable head is transversed by a 5-h. p. Westinghouse type S motor. The distance between the face plates may be varied from 6 ft. 8 ins. to 9 ft. The swing over the bed is 92 ins.; the diameter of the face plate is 90 ins., and the machine will take wheels from 50 to 84 ins. in diameter without changing the position of the carriages. It is driven by a 40 h.-p. Westinghouse type S motor, having a speed variation of from 1 to 2, which, when combined with changes by gearing, provides cutting speeds of from 10 to 25 ft. per minute on all diameters from 48 to 84 ins. During the test as much as 58 to 60 h.p. was required at times to drive the machine. The cutting speed varied from 8 ft. 6 ins. to 14 feet per minute, most of the work being done at 12 ft. 9 ins. per minute.

The tools used are quite similar to those used at the Angus shops, and illustrated on page 56 of this issue. Where no hard spots were encountered the wheel was turned complete in from 21 to 23 revolutions, divided about as follows: Eight or nine for the roughing cut on the tread, three across the top of the flange, and one revolution each to rough down the front and back of the flange; this was all done with one setting of the tool. The scraper was then applied to the tread of the wheel, smoothing it up in two revolutions; two revolutions were required for cutting the outer bevel and chamfering the outside corners of the tread, and two on each side for finish-

TEST OF NILES 90-INCH DRIVING WHEEL LATHE, MIDVALE TIRES—WEST ALBANY SHOPS, NEW YORK CENTRAL LINES.

Date.	Diam. of Wheel Centre, Ins.	Kind of Tool.	Size of Tool, Ins.	Speed Feet per Minute.	Feed per Revolution Ins.	Depth of Cut, Ins.	Distance Traveled, Ins.	Condition of Tool.	TIME USED—MINUTES. Putting Wheel in & Fastening.	Cutting.	Taking out Wheel.	Total.
12—18—'05	50	Rex—A Mushet Rex—A	3x1½ 3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in. 12 ft. 9 in.	15-32 15-32 15-32	5-16 1-4 1-4	5-¾ 3 2-¾	Good. Point burnt off. Good.	7	39	3	49
12—18—'05	50	Rex—A Mushet	3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in.	15-32 15-32	7-16 7-16	5-¾ 5-¾	Good. Good.	7	40	3	50
12—18—'05	50	Rex—A Rex—A	3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in.	15-32 15-32	5-16 5-16	5-¾ 5-¾	Good. Good.	7	41	3	51
12—18—'05	57	Rex—A Mushet Rex—A	3x1½ 3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in. 12 ft. 9 in.	15-32 15-32 15-32	1-2 1-2 1-2	5-¾ 1-½ 4-¼	Good. Point burnt off. Good.	8	44	4	56
12—18—'05	57	Rex—A Rex—A	3x1½ 3x1½	12 ft. 9 in. 12 ft. 9 in.	15-32 15-32	7-16 7-16	5-¾ 5-¾	Good. Good.	7	42	3	52
12—19—'05	57	Rex—A Midvale Rex—A	3x1½ 3x2 3x1½	12 ft. 9 in. 12 ft. 9 in. 12 ft. 9 in.	15-32 15-32 15-32	5-16 7-16 7-16	5-¾ 15-32 5-9-32	Good. Point burnt off. Good.	6	45	2	53
12—19—'05	57	Rex—A Rex—A Rex—A	3x1½ 3x1½ 3x1½	12 ft. 4 in. 12 ft. 4 in. 12 ft. 4 in.	15-32 15-32 15-32	7-16 7-16 7-16	5-¾ 2 3-¾	Good. Point burnt off. Good.	7	46	2	55
12—19—'05	57	Rex—A Rex—A	3x1½ 3x1½	12 ft. 6 in. 12 ft. 6 in.	15-32 15-32	9-16 9-16	5-¾ 5-¾	Good. Good.	8	44	2	54
12—19—'05	57	Rex—A Rex—A	3x1½ 3x1½	11 ft. 8 in. 11 ft. 8 in.	15-32 15-32	1-2 1-2	5-¾ 5-¾	Good. Good.	7	43	2	52
12—19—'05	57	Rex—A Rex—A Rex—A	3x1½ 3x1½ 3x1½	12 ft. 8 in. 12 ft. 3 in. 12 ft. 3 in.	15-32 15-32 15-32	9-16 7-16 7-16	5-¾ 3-¾ 2	Good. Point broken off. Good.	6	42	2	50
12—19—'05	57	Rex—A Rex—A	3x1½ 3x1½	10 ft. 8 in. 10 ft. 8 in.	15-32 15-32	1-2 1-2	5-¾ 5-¾	Good. Good.	6	50	2	58
12—19—'05	57	Rex—A Rex—A Rex—A Rex—A	3x1½ 3x1½ 3x1½ 3x1½	11 ft. 9 in. 11 ft. 9 in. 8 ft. 6 in. 8 ft. 6 in.	15-32 15-32 15-32 15-32	7-16 7-16 3-8 5-16	5-¾ 2 1 2-¾	Good. Point broken off. Point broken off. Good.	6	52	2	60
12—19—'05	57	Rex—A Rex—A	3x1½ 3x1½	11 ft. 11 ft	15-32 15-32	1-2 1-2	5-¾ 5-¾	Good. Good.	7	47	2	56
12—19—'05	72	Rex—A Rex—A	3x1½ 3x1½	14 ft 14 ft	13-32 13-32	3-8 3-8	5-¾ 5-¾	Good. Good.	8	46	2	56
12—19—'05	72	Mushet Mushet	3x1½ 3x1½	14 ft. 14 ft	13-32 13-32	5-16 7-16	5-¾ 5-¾	Good. Good.	7	43	2	52
								TOTAL	104	664	36	804

Weight of chips from 15 pair of wheels 2860 lbs. 15 pairs, 13 hours, 24 minutes. Average 53 3-5 minutes.



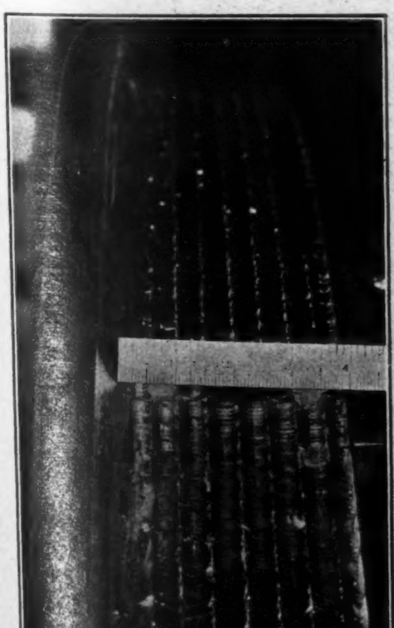
NILES 90-INCH DRIVING WHEEL LATHE—WEST ALBANY SHOPS.

ing the flange. These finishing cuts required four tool settings. We are indebted for information to Mr. R. T. Shea, general inspector of tools and machinery for the New York Central Lines.

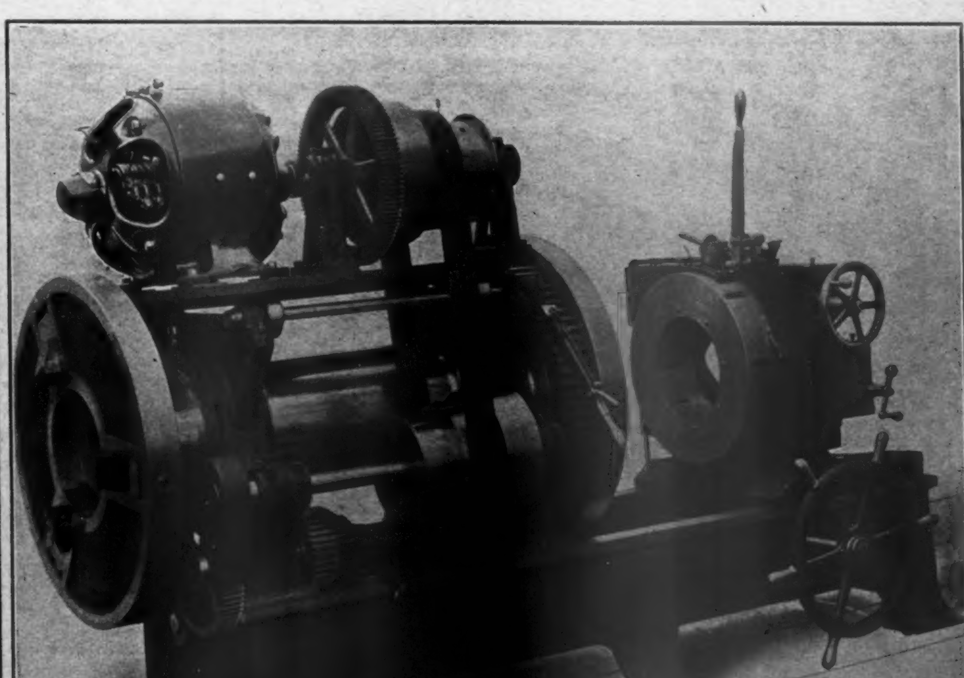
IMPROVED PIPE THREADING AND CUTTING OFF MACHINE.

The Duplex No. 12 improved threading and cutting off machine, made by the Bignall & Keeler Manufacturing Company, Edwardsville, Ill., is equipped with adjustable expanding dies and is designed to thread and cut off standard pipe from 4 to 12 ins. in diameter. Each machine is furnished with nine sets of dies, one for each size of pipe, each set consisting of eight chasers. The chucks have each three independent jaws operated by powerful screws; tempered steel grips, which may readily be removed and resharpened, are dovetailed into the ends of the jaws. The jaws are graduated on the face so that they may easily be set for any size of pipe. Special flange grippers, which are very convenient when making up flanges or flanged fittings, are placed on the outside of the jaws of the rear chuck.

The die head is of a very substantial design and is equipped with the Peerless adjusting mechanism, which is very simple and accurate. Duplicate threads of exact gauge can always be obtained and the gauge may be varied by .001 in. All of the adjustments are made by hand and the dies may be inserted in the head without removing any of the parts. The cutting



SHOWING ROUGHING CUTS TAKEN ON TREAD OF TIRE AT WEST ALBANY SHOPS.

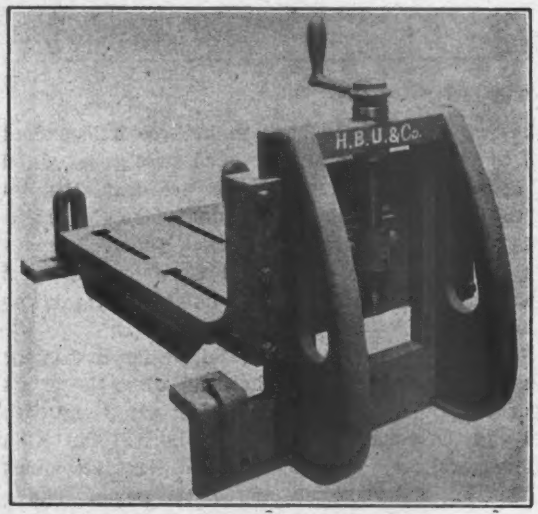


IMPROVED PIPE THREADING AND CUTTING OFF MACHINE.

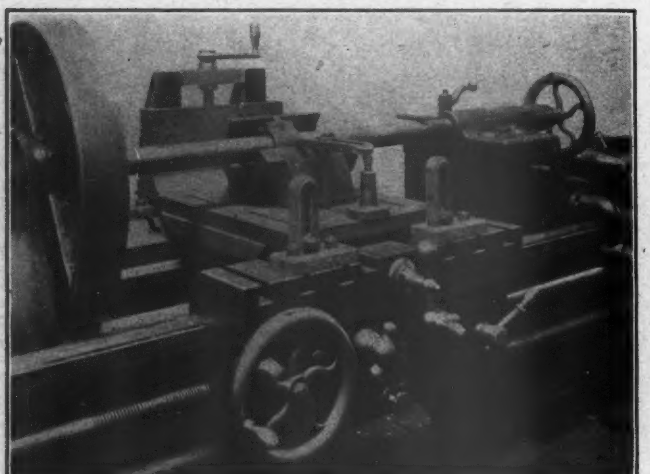
off tool and the steady slides, the latter being equipped with interchangeable steel facings, are placed on the back of the die stand. An automatic oil pump, placed in the bed of the machine, delivers oil directly to the dies and the cutting-off tool. In addition to the three speeds which may be obtained by the cone pulley, an additional set of speeds may be obtained by means of a compound shifting gear. The gears are all machine cut from solid metal. The machine shown in the illustration is equipped with a 5-h. p. constant speed motor. Quite frequently they are driven by variable speed motors with reversible controllers for cutting left hand threads. The machine weighs about 9,000 lbs.

LATHE ATTACHMENT FOR BORING.

The attachment illustrated herewith may be bolted to the carriage of an engine lathe, thus converting it into a horizontal boring machine. It may be made to suit any size lathe. To place it in position, it is first necessary to remove the tool slide and drill and tap two holes in the back of the carriage. The housing is then fastened at the back of the carriage by the two tap bolts and by additional bolts which fit in the T slots and pass through the flange which projects over the top of the end of the carriage. The table, or shelf, to which the work is



LATHE ATTACHMENT FOR BORING.

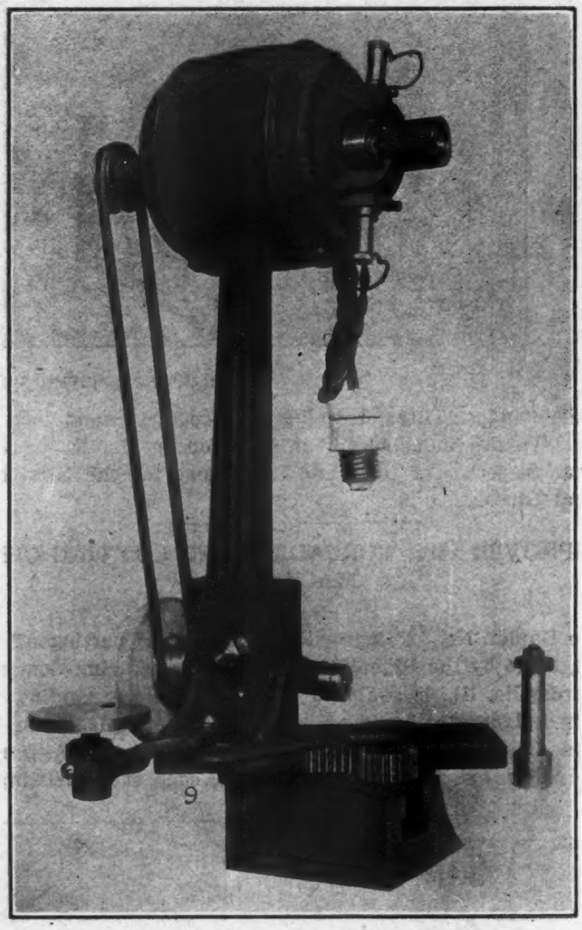


APPLICATION OF LATHE ATTACHMENT FOR BORING.

fastened is in the form of an angle plate, the shorter flange of which is fitted to the slides on the housing. This table may be adjusted vertically by means of the large screw. After it has been adjusted to suit the work, it is bolted at the front to the slotted angle irons which are attached to the carriage by bolts fitting into the T slots on the carriage, as shown. Where heavy boring is to be done, it is desirable to use a 3 or 3¾-in. boring bar, attaching one end to the face plate and the other end in a steady rest, or other suitable bearing. For lighter work the bar may be held between the lathe centers. This device, arranged for a 30-inch lathe, is 31 ins. long, 22½ ins. wide, has a vertical adjustment of 5½ ins. and weighs about 685 lbs. It is made by H. B. Underwood & Company of Philadelphia.

MOTOR DRIVEN PORTABLE GRINDER.

The illustration shows a portable motor-driven grinder built for all kinds of internal and external grinding. Power may be taken from a line supplying incandescent lights, connection being made by means of an ordinary lamp socket. When lathe centers are being ground, the compound slide is used; this is operated by means of a rack and pinion, and is set at an angle of 30 degrees, with the center line of the lathe spindle



MOTOR DRIVEN PORTABLE GRINDER.

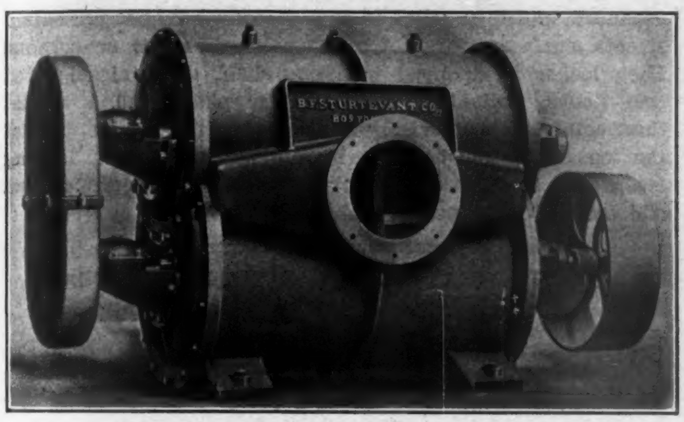
so that it will grind centers to a 60-degree angle exact without the use of the compound slide. This grinder may be placed on the tool slide of any lathe and may be used for internal grinding by mounting the small arbor and wheel in place of the larger wheel. Vertical adjustment is provided to bring the spindle up to the center line of the lathe spindle. The small rest is used for trueing up emery wheels and for sharpening cutters, saws, etc. Provision is made for taking up the slack in the belt, also to take up the wear on the spindle and protect it from the dust. This device is made by the Mueller Machine Tool Company, Cincinnati, Ohio.

STURTEVANT HIGH PRESSURE BLOWER.

The Sturtevant high-pressure blower is made in two types: in the horizontal the two shafts lie in a horizontal plane, while in the vertical, one shaft is above the other. The blower consists of a cast-iron shell, or housing, in which are two rotating members, or "rotors." One of these, the impeller, revolves in the larger portion of the casing, which, in the vertical type, is the lower. It does the real work of compression. The other rotor, known as the idler, does no work; it successively provides spaces or chambers of proper shape at the desired points in the revolution, so that the impeller blades

may return to the suction side of the blower without allowing the escape of compressed air.

Ample clearance between the rotating members and the casing insures high mechanical efficiency by absolutely preventing internal friction due to contact of metal surfaces. The idler, or drum, revolving in the smaller part of the casing, which, in the vertical type, is above the impeller, is symmetrical and has a periphery nearly a complete circle. It consists of three hollow vanes or blades cast in one piece with the shaft, which is of cast iron. The idler, revolving with large clearance, is turned at the same speed as the impeller by means of two spur gears running in oil and incased for protection against dirt and accident. The impeller, mounted on the driving shaft, is made up of three diamond-shaped bars



STURTEVANT HIGH PRESSURE BLOWER.

take is successively imprisoned in the three pockets formed by the three blades of the revolving impeller, and discharged at any desired pressure up to 10 lbs. per square inch. The volume of free air delivered varies directly with the number of revolutions; the pressure varies with the resistance met in the delivery pipe. The principle upon which the blower operates is clearly shown by the accompanying diagrams, which are sectional views of the rotors and casing. In the explanation it is assumed that the blower is running at a speed to produce average pressure, and that this pressure exists in the discharge outlet.

While the rotating members are in the positions shown in Fig. 1, air enters freely and completely fills the chambers X and D, while pockets E and Z are discharging air to the delivery pipe. From the previous movement of the rotors, the pressure in Y, filled with air carried over by the revolving idler, had been increased slightly by air flowing through the leakage passage N, as will be explained later. The space between blades A and C, just above the concave portion of the core, is practically filled by the wing of the idler, and consequently while in this position it takes no part in the action.

While revolving from the position of Fig. 1 to that shown in Fig. 2, the air in pocket D has been carried along, and the communication between chamber D and the inlet has been cut off. Space Z is filled with compressed air, which further movement will carry toward the suction end, where it will flow back to the inlet and in escaping cause noise. But this noise and loss is prevented by the leakage chamber O, which allows the pressure to be transmitted to the air in space Y, thereby increasing its density just before it is discharged.

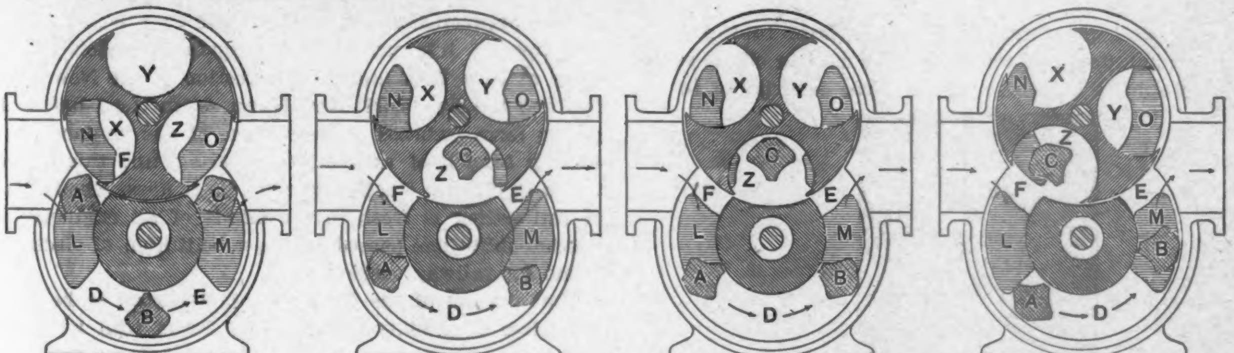


DIAGRAM SHOWING OPERATION OF STURTEVANT HIGH PRESSURE BLOWER.

or blades and a central web, which is keyed to the steel shaft. As it revolves three separate pockets are formed in the annular space between the shell and a core extended lengthwise of the lower part of the casing. In reality the core is in two parts, each cast in one piece with the end plates, the space between them allowing the web to revolve.

The cast iron shell or casing, consisting of two hollow cylinders partially intersecting, is accurately bored. The ends of the casing are finished to receive the four cover plates, in which are cast chambers or passages for lessening the noise, and increasing the efficiency of the machine, as is explained later. On either side of the housing are openings for the intake and the discharge of the air, flanged and tapped for standard gas pipe fittings; the small sizes have openings at the sides, and the large blowers openings at the top and bottom. In every respect the casing and rotors are symmetrical, permitting the blower to run in either direction. Except in blowers of large size, the lower half of each journal box is cast in one piece with the cover plate, insuring rigidity, simplicity and correct alignment. When it is desired to maintain absolutely constant pressure, the blower is provided with a relief valve, or automatic governor. For transferring gases and air at high-pressure stuffing boxes are provided for the shafts, and a drain in the bottom removes tar and other distilled liquids.

OPERATION.

Air at atmospheric pressure entering the blower at the in-

DETAILS OF STURTEVANT HIGH PRESSURE BLOWER.

Continued rotation carries the rotors to the position shown in Fig. 3; air at atmospheric pressure is now entering pocket F, the air in D is being carried around between the blades A and B in the annular space, and E is discharging. Above the impeller the remaining pressure in Z is being transmitted to the air in X by means of the leakage passage N provided for the purpose, thereby making its pressure slightly greater than atmospheric. The air in space Y under slight pressure from previous leakage is imprisoned and being carried around by the idler.

When the fourth position is reached pocket F will be filling,

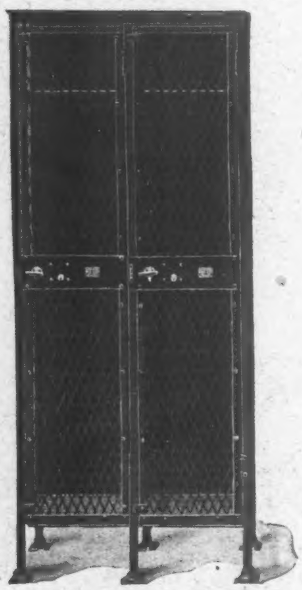
the pressure in chamber Z will have been reduced to atmospheric by leakage, space Y will discharge, and a little compressed air from the delivery pipe will flow back through leakage passage M and increase the pressure in D, which will result in a quieter discharge when further movement brings B into the discharge passage.

The purpose and advantage of the leakage passages is now apparent; they make it possible to recover the pressure tending to escape from the impeller pockets, and by making the increase in pressure gradual cause the blower to run with less noise. Leakage passage L has little effect when the blower runs in the direction shown here; it is made to allow the blower to be reversible. It will be noticed that the impeller carries three blades, set at equal distances around the periphery, thus causing three admissions of air at each revolution. Upon leaving the position shown in Fig. 4 the rotors quickly reach a position in which the conditions are exactly the same as those shown in the first figure, the operation continuing as explained.

PEN-DAR METAL LOCKER.

Within the past three years metal office furniture and fixtures have proven their worth so strongly that at the present time an office or factory to be considered thoroughly up-to-date must have its equipment, such as lockers, filing cabinets, cases, tables, etc., made of sheet steel. In comparison with wood as material for such furniture, steel possesses every advantage. Its use means greater convenience and economy; it enforces more system and saves employees' time; it encourages neatness and cleanliness, prevents waste and gives increased protection against fire.

Several state legislatures have passed laws to the effect that nothing but steel equipment shall be used in offices where valuable records and documents are filed, even going to the



PEN-DAR METAL LOCKER.

extreme measure of condemning the present wood fixtures. Our banks, insurance companies and large corporations are rapidly realizing the importance of this question, and architects and engineers are gradually beginning to admit the fact that no matter if a building is constructed of fire-proof material, it is not fire-proof when filled with a great mass of wooden fixtures.

The experimental stage has gone by and the future will see our fire-proof buildings not only fitted with steel lockers, vaults and cabinets, but, in short, every movable piece of furniture will be of metal. To corporations employing a large number of men, one of the main requisites is clothes lockers and, where space is valuable, the installation of this important equipment is a matter of much thought. Being made entirely of open mesh, the metal locker allows a free circulation of air, in consequence of which it is well ventilated and sanitary. Moreover, the contents of each individual locker can be thoroughly inspected at any time. They can be easily fumigated without the articles in the locker being removed. They are germ-proof, fire-proof and time savers.

A complete line of metal furnishings, known as the "Pen-Dar" system, is made by Edward Darby & Sons' Company, Inc., of Philadelphia; these manufacturers include in their system such specialties as metal lockers, shelving, partitions, tables, cabinets, etc. The Pen-Dar metal lockers are made in groups and sizes, according to requirements or specifications, and can be made entirely of open mesh or of sheet steel and on the "unit" system.

The new Pen-Dar expanded metal locker is made of expanded metal by a new process, patented under date of April 25, 1905. This metal is made from a sheet of planished steel plate, cut, expanded, and then rolled in such a manner that it presents a smooth surface entirely free from rough edges or corners. Each locker is equipped with one shelf, three nickel-plated coat hooks, individual brass number plates and a special three-point locking device, which securely fastens the door at the top, center and bottom with a single turn of the locking lever. All locks are provided with two non-changeable keys, and each set is master keyed.

ELECTRIFICATION OF THE PENNSYLVANIA RAILROAD.

Up to the present time the principal advance in the electrification of steam roads has taken place at the terminal stations or upon branch roads, so that the recent decision of the Pennsylvania Railroad to equip electrically a portion of their system between Camden and Atlantic City, New Jersey, is of the greatest interest. The developments which have taken place at New York under the direction of the New York Central and the New York, New Haven & Hartford Railroad Companies have focussed the attention of the engineering world on this branch of railroad engineering, and this further advance of electric traction coming, as it does, when this phase of railroading is fresh in the minds of all engineers, marks another milestone passed in the substitution of electricity for steam for railway service.

That portion of the Pennsylvania Railroad to be electrified comprises some sixty-four miles of steam road lying between Camden and Atlantic City, New Jersey, being a portion of the West Jersey and Seashore branch of the Pennsylvania system. It is proposed to utilize the Cape May line of this system from Camden as far as Newfield, this line being double-tracked with 100 lb. rails, and to build an additional track from Newfield to Atlantic City, making the lines double-track throughout. Over this roadbed, an express service will be established. The initial installation will provide for a three-car train every fifteen minutes between Camden and Atlantic City, making the sixty-four miles in eighty minutes without stops. The maximum speed of the cars will be between 55 and 60 miles per hour.

In addition to this through service to Atlantic City, a half-hourly schedule is planned, consisting of two-car trains between Camden and Millville, 40 miles, and ten-minute service of single cars between Camden and Woodbury, 8½ miles. Full service will call for 58 cars in operation, each equipped with two 200 h.p. direct current motors, known as GE-69. These motors will be similar to those now being manufactured by the General Electric Company for the equipments of the New York terminal of the New York Central & Hudson River Railroad. The motors will be controlled by the Sprague-General Electric automatic multiple unit system, which will permit the operation of cars in trains, all of the motors being under the control of the motorman in the cab of the forward car. Current will be furnished to the cars by the third rail system, except on the sections between Camden and Woodbury and Newfield and Millville, where the cars will obtain the necessary current by an overhead trolley. The speed on these sections is less than on the main line.

The power house will be located at Camden. Power for the operation of the cars will be furnished by three 2,000 k.w. General Electric Curtis turbo-generators of the three-phase alternating current type, having a frequency of 25 cycles. From this power house transmission lines will be run to six sub-stations between Camden and Atlantic City, and a seventh sub-station at Millville to supply that section of the road lying between Millville and Newfield. The transmitting potential will be 33,000 volts. At the sub-stations a total capacity of 11,000 k.w. in rotary converters will be provided, delivering direct current to the third rail at 650 volts. The individual units will be of the standard General Electric type, and will have a capacity of 750 k.w. They will be started from the alternating current end by means of taps on the stepdown transformers.

The contract calls for the completion of this road by July 1, 1906, in order to take care of the heavy summer traffic. The total amount of money involved is about $3,000,000. The electrical equipment will be furnished by the General Electric Company.

MOTOR DRIVEN TOOLS AT THE McKEES ROCKS SHOPS.

To the Editor:

On pages 32 and 33 of your January issue you quote certain figures from a paper by the undersigned, read before the Engineers' Society of Western Pennsylvania. The figures for labor cost are rather misleading. They are, apparently, the cost of labor for repairing and building locomotives in the machine and erecting shop, whereas the figures for both years, 1903 and 1904, cover all labor performed at McKees Rocks during those years, which was charged to locomotive repairs, irrespective of whether repairs were made to locomotives in the shop or running repairs in the round house, the latter including replacing of boiler tubes, drop-pit work, stay-bolt work, and the regular running repairs. These charges also include the labor cost on all material made up in the blacksmith shop, boiler shop, machine shop and the cab and tender shop as stock, the labor being charged to locomotive repairs and a large portion of the material being sent to outside points to be applied to locomotives. The actual labor charged against the locomotives shown as undergoing repairs and built in the shops would be, approximately, one-half the figures given, or, say, $110,000 for 1903 and $130,000 for 1904.

The significance of the figures for the two years lies in the fact that, while the cost for running repairs was practically the same during both years, the output in the manufacturing shops was more than doubled, at an increase of only $20,000 in the payroll. I will be very glad if you will give this letter prominence, as the figures, as they appeared in the article above referred to, would indicate that the cost of labor for locomotives undergoing general overhauling was entirely too high. G. M. CAMPBELL.

BALDWIN LOCOMOTIVE OUTPUT.—During the year 1905 the Baldwin Locomotive Works turned out 2,250 locomotives. Of this number 140 were electric and 115 were compound, mostly of the balanced type, although there were a few tandem compounds among the number; 406 were for export. The average number of men employed was 14,811, the works being operated night and day.

PERSONALS.

Mr. W. P. Chrysler has been appointed master mechanic of the Chicago Great Western Railway at Oelwein, Ia., to succeed Mr. J. E. Chisholm.

Mr. F. S. Anthony, formerly of the Atlantic Coast Line, has been appointed master mechanic at Pen Argyl, Pa., to succeed Mr. Shields.

Mr. E. B. Hughes has been appointed general foreman of shops of the Wabash Railroad at Tilton, Ill., in place of Mr. John Baird, resigned.

Mr. C. H. Quereau, engineer of tests of the New York Central & Hudson River Railroad at West Albany, N. Y., has been appointed superintendent of electrical equipment of that road.

Mr. L. S. Storrs has been appointed engineer of tests of the New York, New Haven & Hartford, with office at New Haven, Conn.

Mr. George Schwartz has been appointed foreman of machine shops of the Wabash Railroad at Fort Wayne, Ind., succeeding Mr. Hughes.

Mr. H. C. Shields, former master mechanic of the Lehigh & New England Railway Company, has been appointed superintendent of the same road, with offices at Pen Argyl, Pa.

Mr. A. B. Bardsley has been appointed master mechanic of the Gulf & Ship Island Railroad, with office at Gulfport, Miss., to succeed Mr. M. S. Curley, resigned.

Mr. R. A. Johnson has been appointed master mechanic of the Sonora Railway, with offices at Guaymas, Mexico, vice Mr. S. E. Kildoyle, resigned.

Mr. A. W. Byron has been appointed assistant master mechanic of the Buffalo & Allegheny Valley division of the Pennsylvania Railroad at Olean, N. Y.

Mr. Ellsworth Brown has been appointed assistant road foreman of engines of the Buffalo and Rochester divisions of the Pennsylvania Railroad at Buffalo, N. Y.

Mr. J. E. Chisholm, heretofore master mechanic of the Chicago, Great Western at Oelwein, Ia., has been appointed general master mechanic of that road, with office at Oelwein, Ia.

Mr. J. E. Keegan, heretofore master mechanic of the Grand Rapids & Indiana Railroad, has been appointed superintendent of motive power, with headquarters at Grand Rapids, Mich.

Mr. S. M. Hindman has been appointed general car inspector of the Buffalo & Allegheny division of the Pennsylvania Railroad, with office at Buffalo, N. Y., vice Mr. J. P. Yergy, promoted.

Mr. A. N. Willsie has been appointed master mechanic of the Brookfield division of the Chicago, Burlington & Quincy Railway, with headquarters at Brookfield, Mo., vice Mr. W. W. Lowell, transferred.

Mr. John Hartung, foreman of the car repairing department of the Louisville & Nashville shops in New Decatur, has been promoted to general foreman of the car department of the Nashville-Decatur division and all branch roads.

Mr. J. H. Williams, roundhouse foreman of the Lehigh Valley Railroad at East Buffalo, N. Y., has been appointed master mechanic at Wilkes-Barre, Pa. Mr. Thomas Madigan has been appointed to succeed Mr. Williams at East Buffalo.

Mr. George Dunsmore, foreman of shops of the Erie Railroad at Susquehanna, Pa., has been appointed general foreman of shops of the Buffalo, Rochester & Pittsburgh at Dubois, Pa., in place of Mr. C. S. Diegel, who has been transferred to Rochester, N. Y., in a similar capacity.

Mr. C. Kyle, master mechanic of the Lake Superior division of the Canadian Pacific, has been transferred to the Eastern division at Montreal. He succeeds Mr. J. B. Elliott, recently appointed general master mechanic of lines east of Fort William. Mr. Kyle will be succeeded at North Bay by Mr. G. T. Fulton, formerly general foreman of the Carleton Junction shops.

Mr. A. A. Scott has been appointed locomotive inspector at the Angus shops of the Canadian Pacific Railway at Montreal, Que. Mr. E. Marshall has been appointed locomotive foreman at Outremont, Que., in place of Mr. Scott, and Mr. J. Wilkinson has been appointed locomotive foreman at Hochelaga, Que., to succeed Mr. Marshall. Mr. C. A. Stark, locomotive foreman at Ottawa, Ont., has been transferred to Carleton Junction, Ont., as general foreman.

M. S. Millican has been appointed superintendent of motive power and machinery of the Houston & Texas Central, Houston, East & West Texas, and the Houston & Shreveport, in which capacity he has been acting since the resignation of Mr. S. R. Tuggle about a year ago.

CATALOGS WANTED.

The mechanical engineering department of the Louisiana State University wishes to get together a complete file of manufacturer's catalogs and trade literature. They will greatly appreciate the courtesy if those interested will kindly send literature of this kind to Mr. E. W. Kerr, professor of experimental engineering, Louisiana State University, Baton Rouge, La.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

Extra Heavy Valves.—Jenkins Bros., 71 John street, New York, are sending out a small pamphlet devoted to extra heavy valves for pressures above 150 lbs. per sq. in.

Automatic Slack Adjuster.—The American Brake Company, 1932 N. Broadway, St. Louis, Mo., are sending out a catalogue descriptive of the various forms of the American automatic slack adjusters.

Circuit Breakers.—Circular No. 1107 from the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is devoted to a description of the different types of the Westinghouse automatic circuit breakers, carbon break.

Planers and Shapers.—Catalog No. 5, from the Hamilton Machine Tool Company, Hamilton, O., describes the various planers and shapers made by them. In addition several pages are devoted to motor applications to these machines.

The Dill Slotter.—The T. C. Dill Machine Company, Philadelphia, Pa., are sending out an interesting catalog describing the Dill slotters. Among other features, they are equipped with a travelling head which greatly increases the range of the machine.

Soft Water.—This is the title of a pamphlet, issued by the Pittsburgh Filter & Manufacturing Company of Pittsburgh, Pa., which is devoted to the question of water softening and a description of the various types and designs of apparatus which this company is prepared to install.

Electrical Apparatus.—Bulletins Nos. 1046, 1047 and 1048, from the electrical department of the Allis-Chalmers Company, are devoted to the Bullock multipolar motors and generators, types H and HI; Bullock oil insulated transformers and Bullock alternating current generators of the engine and fly wheel types.

Combined Pressure and Recording Guage.—"The recording gauge is to the coal pile what the time clock is to the pay roll." This sentence is the introduction to a circular sent out by the American Steam Gauge Valve & Manufacturing Company, Boston, Mass., which considers the advantages of the American combined pressure and recording gauge.

Electric Hoisting Machinery.—Bulletin No. 62, from the Crocker-Wheeler Company, Ampere, N. J., is devoted to electric hoisting machinery. The Crocker-Wheeler standard electric hoists and winches, and also a double drum electric hoist with boom swinging drum are described and illustrations are presented of a number of applications of their motors to hoisting machines of all kinds.

Walschaert Valve Gear, as Applied to Large American Locomotives.—This is the title of a very interesting and important pamphlet published by the American Locomotive Company. It considers briefly the advantages of the Walschaert gear and illustrates several large American locomotives equipped with it, including the heaviest passenger, freight and switching locomotives ever built. Line drawings are introduced showing the arrangement of the gear. The relative weights of the various parts of the Stephenson and Walschaert valve gears for three engines are tabulated and some service results with this gear are presented. In addition there is a specially prepared article, giving a general description, directions for adjusting valves and method of laying-out the Walschaert gear, which was prepared by Mr. C. J. Mellin and reproduced in the January issue of this journal.

Pipe Thawing Apparatus.—This is the title of an interesting folder No. 4051 issued by the Westinghouse Electric & Manufacturing Company, Pittsburg, Pa. Their apparatus for doing this work is described and an interesting table is presented, compiled from actual results, which shows the length of time for thawing different sizes and lengths of pipe under varying conditions.

NOTES.

Wm. B. Scaife & Sons Company.—This company, of Pittsburg, advises that they have received a contract for the structural steel work for the new building of the Southern Bell Telephone Company, Atlanta, Ga.

H. W. Johns-Manville Company.—This company, of New York, announces that Mr. William T. Butler will represent them in the Pacific Coast territory. His headquarters will be at San Francisco, with branches at Los Angeles and Seattle.

Standard Roller Bearing Company.—This company, of Philadelphia, advises that they have just started the erection of a brass and iron foundry, 60 by 125 ft., two stories in height. Their new crucible steel casting plant was put in operation last December.

The Ingersoll-Rand Company.—This company, of New York, announces that they have secured exclusive control of the products of the Imperial Pneumatic Tool Company, with shops at Athens, Pa. This line of tools is well known and includes pneumatic hammers, drills, riveters, reamers, hoists and plug drills.

Railway Appliances Company.—Mr. James L. Pilling has become associated with the Railway Appliances Company, of Chicago, and they will be pleased to receive inquiries relative to improved compressed air locomotive turntable devices and also portable and stationary hoisting engines for all purposes, all being equipped with the Pilling improved engines.

Weir Frog Company.—This company, of Cincinnati, announces that the Louisville and Nashville Railroad has contracted with it for the supply of all frogs and switches for 1906. This is a practical testimony as to the excellence of the Weir Company products and facilities, since it is the renewal of a contract held continuously since this company moved into its plant at Norwood.

Foote, Burt & Company.—This company, manufacturers of multiple drills at Cleveland, announce that they have purchased the plant, patterns, and good-will of the Reliance Machine & Tool Company, manufacturers of bolt cutters, bolt pointers and nut tappers. The plant will be removed to the present quarters of Foote, Burt & Company, making necessary an addition of about one-third more floor space than now occupied by them. The shop-men will be given employment, although none of the executive staff of the Reliance Machine & Tool Company will be retained.

The Kempsmith Manufacturing Company.—This company, of Milwaukee, Wis., announces that the work on the 75 by 45 ft. two story addition to their works is being rapidly pushed and that they are installing a new Corliss engine which will double the power capacity of the plant. The heavy demand for their improved types of milling machines is making it necessary to add a large amount of new equipment for their manufacture.

Chicago Pneumatic Tool Company.—This company, of Chicago, announces that the demand for their air compressors is such that they are making arrangements to increase the capacity of their works at Franklin, Pa., to give an annual output of between 650 to 700 compressors instead of 400 which was the output for 1905. Considerable business was lost during 1905 because of inability to make deliveries. They also announce that they have been awarded the gold medal at the Liege Exhibition for their pneumatic tools and appliances and a silver medal for the Franklin air compressors.

The American Blower Company.—This company, of Detroit, reports that it is furnishing mechanical draft apparatus for the Huntsville (Alabama) Railway Light & Power Company; the New York, Susquehanna & Western Railway Company at Rochelle Park, N. J.; the C. B. & Q. Railway Company at St. Paul and Chicago; the Lackawanna Coal Company at Olyphant, Pa., and the Lehigh Coal & Navigation Company at Lansford, Pa. They are also furnishing heating apparatus for some of the Pennsylvania Railroad Companies' new shops at Allegheny; for the Lincoln Park shops of the B. R. & P. Railway at Rochester; Kingsland (New Jersey) shops of the Delaware, Lackawanna & Western, and for the Schenectady Works of the American Locomotive Company.